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UNIFICATION OF CERAMIC TECHNOLOGY

IN a recent lecture Dr. James White of the Refractory Materials Department of the University of Sheffield, referred to the vertical sub-division of the ceramic industry into functional groups such as potter, building, refractories and so on, which has accentuated a regional as well as functional separation. He went on to say "I think this has tended to prevent the development of any clear sense of unity of ceramics as a whole and has tended to prevent any conserted action." He pointed out that this division was reflected in the different groups of the Ceramic Society where there tended to be a division of interests.

It was precisely for this reason that about 18 months ago this journal was introduced. Articles in it have been abstracted in every division of the *Abstracts of the British Ceramic Society*, thus indicating the scope of CERAMICS.

In this established journal, editorial pages cover ceramics in their widest form. No attempt had been made in British technical journalism to co-ordinate the industry in a manner similar to American Publications. American readers of a journal such as *Ceramic Industry*, whether they work in vitreous enamelling, pottery, refractories or the heavy clay industry do insist that a knowledge of the things happening in related fields as well as in that of their own specific industry has made for unified progress all along the line.

That support for the idea should come from someone as intimately connected with the industry as Dr. White is, to say the least, very heartening to the publishers of CERAMICS.

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AMERICA THINKS!

by **ARGUS**

Under the title "Who Gets the Welfare State's Welfare?" 'Ceramic Industry' says:—

"In England you would think the workers who voted in the Welfare State would be the ones to reap the benefits. They are not. It is the politicians. It was just this past summer that the Welfare State used troops to break a dock-workers' strike.

"When it takes over an industry, the Government becomes an employer and is just as anxious as any other employer to make a profit. There's one big difference however. The Government as an employer can force a profit. Speed-ups can be required and wages can be cut by the simple expedient of taking back in taxes more and more of what it pays out. England's Welfare State has done both. In such a State the real wages go down to keep the bureaucrats in their well-paid tax-free jobs.

"Without the incentive and hope of profit the people of the Welfare State produce less, so costs and prices go higher.

"Without competition between firms bidding for your business, quality is poor, material is shoddy, food is bad and everything takes on a drabness. Work gets harder, and faster. Taxes get higher and food gets scarce and there is nothing to look forward to for you or your children. Unless you're a politician, of course."

No Right to Criticise

IT is all right if we say it about ourselves but a family is a family! Brothers and sisters fight a bloody feud inside the home but when an outsider starts on any one of them it is the surest way to family unity. No doubt much of this is true enough—we have been saying so editorially for many months now. Maybe America does not like our Welfare State but until their own hands are clean it helps little for them to do our criticising for us! You see a Welfare State supporter might say "Who are these guys to talk about rights and wrongs? What about the little chap Ben Hecht who had a 'little song' in his heart when a British Tommy 'bit the dust.' How do they feel about Korea? What about the Lynch Law? Votes for the Whites but not for the Blacks! Yet blacks are good enough to fight in Korea!" In the same issue comes news of sweated labour in Puerto Rico attributed to a "lax American Government."

Lay off chums! We put in this Government and when we are sufficiently dissatisfied, we will put them out. When America has cleaned up American politics, eradicated graft, bootlegging, divorce profiteering, celluloid sensuousness, the coloured question and literary pornography; and welded their newly discovered land into a nation with a tradition—good or bad—then perhaps we in Britain will sit up and take notice.

Or look at the American *Iron Age* just as the Korean business broke:

"The four horsemen of inflation, hoarding, speculation and confusion are out of the barn. It has taken over 2 months for Congress and the President to get around to locking the barn door. Whether the damage done can be repaired is doubtful . . .

"There must be a goat. The Administration and those Congressmen who fiddled while America smouldered in ignorance of what was happening will demand one. So let's place the blame where it belongs right now.

"We were not prepared for the outbreak in Korea. That is not the people's fault. It isn't the fault of industry. The Administration is at fault . . .

"People are people. They look to

leaders. This time they had none. All we had was a slow motion picture of an ordinary Government at work aided or abetted by an ordinary Congress. The few exceptions were like babes hollering in the woods.

"Don't blame industry. Don't blame the people. When the four horsemen return to the stable, remember who forgot to lock the barn door."

No one likes anybody!

Tariff on Pottery

Just passing off from there one notes a plea emanating from America for tariffs on foreign imported pottery. One gentleman, a Mr. Earl Crane says "it's absurd!" Claim for a tariff when the productivity of the American pottery worker is more than three times greater than in Britain. Here are the wage comparisons issued by the American Vitreous China Association in cents per hour. U.S.A. 135; U.K. 36; Belgium 26; France 26; Germany 24; Italy 23; Czechoslovakia 20 and Japan 10. But the Vitreous China Association says that by these figures the productivity of the pottery industry in America would have to be 4½ times that in Britain, 5½ times Germany and 13½ times Japan to obviate the necessity for a tariff on those grounds. It adds that, if Mr. Crane does not believe this why has he established a factory in Puerto Rico (referred to above) where the wage rate is one-third of that in America.

The point is that America is getting windy about these vast imports from overseas. Tariff claims are already being pressed so it looks as though the dollar market for British goods is fast becoming difficult:

Soon someone, somewhere, must "plan" something!

Nationalisation

But let's come back over here. What has been happening recently? Somehow I cannot remember load shedding of electricity in the past but now it has become part of our life, like queues. Trouble about nationalisation is that they have got all the switches together now. In the old days for a public utility to stop was almost heresy! Now if someone has forgotten to oil the turbo-generator he just pulls over a nationalised switch and gets on with his job. That things like tunnel kilns might blow up, or folks handling dangerous materials and plant in a factory might die—I saw a crusher the other day which has already mixed up a human being with its flint by daylight—could not matter less to these bureacratic automatons who have fingers and thumbs but no thought arising from common sense.

You want some coal. Well wait till 1965, the Coal Board's got a plan—the title sounds like that exotic character who floats around Hyde Park with his cry "I've got a horse!" Maybe the tipster does not work on mathematical co-ordination but he is a sight more scientific than the Coal Board's statisticians. In 1965 having spent more than 600 millions of pounds sterling—if we have that much money left by then—we will get 240 million tons of coal a year! Of course we might need more or less—it all depends upon whether full employment continues, and the Coal Board are uncertain about that. Maybe this amount will be too much, or perhaps too little—but it is as good a guess as anybody elses.

The Results

Frankly, we have now got fuel co-ordinated, nationalised or integrated, and as a result we have load shedding which we have never had before; we have coal both wickedly expensive and 10 per cent. muck; gas has leaped up in price by leaps and bounds and the last lot of coke I bought reached a new time price level of nearly £5 per ton! Never before in our history have so many people run such a large slice of our industry to produce so few of the things we really need at a price which nobody can afford to pay.

Listening to Michael Foot the other night on television, ably supported by a University Don called Taylor, and representing between them two Socialistic weekly reviews. They apparently accepted the plan for coal when it stated that mechanisation of the pits along traditional lines seemed to be leading to a lower and lower relative productivity. The suggestion that imported foreign labour should be used was treated by Taylor in comparison with coolie labour! He said in effect that there was no answer to the question of getting more coal! Michael Foot was quite happy with things in the coalfields as they are—he certainly did not offer any constructive suggestions as how to better them. Young Michael is an up and coming young boy in the Government and perhaps he ought to know. If he is pushing over the party line it is time someone gave him a push . . .

I am heartily fed up with hearing people for whom the world has run fairly sweetly, condemning so many other people who have put much more into this country than them, as being responsible for grinding the faces of the poor in the mud! There are more examples of local boys making very good in the present Government than anywhere else before. Maybe the criticisms of the old parliamentary system were that they did preserve their favourites. But today becoming an M.P. in itself opens up avenues to remuneration which were denied members in the days before the Government had an executive control of industry, and therefore had the chance to dish out patronage.

And back to my American correspondents. You see I don't like the present set-up—but I am entitled to have a go at it, not you.

LABORATORY MACHINERY

WE have received a most interesting publication (No. 9602) from Sturtevant Engineering Co. Ltd., Southern House, Cannon Street, E.C.4, under the above title. It replaces publication No. 9601, which is now out of print, and copies are available to interested parties on request.

With the importance now being attached to pilot plant work and to small-scale laboratory development leading to this, the range of equipment offered will find many uses in the development departments of a variety of industries. Examples include a rotary fine crusher in two sizes, No. 000 with a capacity of 1-2 cwt. of coal per hr. and No. 00 with a capacity of 10-15 cwt. of coal per hr. A laboratory swing sledge mill suitable for hard, tough and fibrous materials from 3 in. cube to 20 mesh is available with an output of 250-1,000 lb. 10 mesh per hr. Laboratory roll jaw crushers have outputs of 100 250, 600 and 1,000 lb. per hr. Also available are laboratory crushing rolls and end runner mills. Laboratory sample grinders, bore mills, batch mills, vibrating screens and test sieves are mentioned. In addition, reference is made to a laboratory disintegrator, a sample splitter, a rotory dryer, a pan mixer and a porcelain pot mill. An interesting article of equipment is the laboratory whirlwind separator.

Altogether this is a most useful catalogue, providing specification details as it does, for those engaged in industrial development work.

THE GAUGE AND TOOL EXHIBITION

THE Gauge and Tool Makers' Association are holding their third Exhibition in the New Hall of the Royal Horticultural Society, Elverton Street, Vincent Square, S.W.1, from the 15th 25th May, 1951. It will be open daily except Sunday from 10.30 a.m. to 7 p.m.

Engineering equipment manufactured by members of the Association will be displayed as follows:

Gauges and measuring equipment; jigs fixtures and special tools; special-purpose machines and equipment, press tools, portable power tools; moulds and dies; engineers' small tools and diamond tools

THE MANUFACTURE OF CERAMIC COLOURS

(Specially Contributed)

COLOURS are applied to ceramic ware in the following ways:

(a) The body is coloured by adding a stain in the preparation.

(b) A coloured slip or engobe is put on the surface of the clay ware and fired, and the article is subsequently glazed.

(c) Under-glaze decoration.

(d) On-glaze decoration or enamelling.

(e) In-glaze, in which the glaze is coloured by addition of a stain. Glasses and vitreous enamels are coloured in the same way.

The colours themselves are oxides or other chemical compounds, and their colouring action is brought about either by forming coloured silicates, or alumino and boro-silicates, with the body or glaze on firing, or by remaining fixed to the ware unchanged, or suspended in the glaze. Thus, for example, cobalt oxide gives a blue coloration in glazes due to the formation of a cobalt alumino-silicate, while green chromic oxide remains suspended, and in concentrations above about 3 per cent. will give a green opaque glaze. The latter is sometimes used on red ware and other bodies of a poor colour.

Stability of Colours

It follows that the stability of the compound to heating will determine whether it is suitable as a ceramic colour at all, and whether it can be used over a restricted range of temperature, such as in the enamel kiln for on-glaze decoration where the temperature required will not exceed about 750° C.

Since the number of available compounds which will stand heating to this temperature is comparatively large, the colour pallet available for on-glaze or enamel decoration is greater than with under- or in-glaze. The smallest range of colours is found with under-glaze decoration on hard paste Continental porcelain, where the final firing temperature may reach 1,350°-1,400° C.

Classification of Colours

A convenient division of ceramic colours is:

(a) those which are oxides, which on firing react to form coloured silicates, *e.g.* cobalt oxide, or alternately the oxide is coloured and remains unchanged in firing *e.g.* green chromium oxide.

(b) Coloured compounds or salts. Examples of this are lead antimoniate, called Naples yellow, and basic lead chromate (coral red).

These remain unchanged either on, in, or under the glaze. Whether they can be used in or under glaze depends on their stability to heat. Generally speaking coloured salts are mostly used for on-glaze decoration, since most of them decompose on heating to glost temperatures or vaporise away, *e.g.* selenium red.

Naples yellow is sometimes used under glaze with tin oxide added as a stabiliser, but it needs careful heating to prevent the colour breaking down and must be under a suitable glaze.

The preparation of colours is an ordinary chemical process. Since the shade obtained varies with the mode of preparation in some cases, careful attention to detail is

required. The variation is probably connected with size of the colour particles, which is influenced by the mode of preparation. The operations can be summarised briefly as:

1. initial weighing, mixing and preparation;
2. calcination;
3. washing;
4. grinding and packing.

Preparation of Materials

Where it is necessary to prepare some of the components from more readily available materials, strict control is necessary, since the final colour may be influenced by the method used. It is a well-known fact that the colour of cadmium sulphide can vary with the conditions of preparation, from a deep ochre to pale yellow, and the same applies to many other coloured compounds.

Where the compound itself is not coloured, but is used as an ingredient of a mixture, the method of preparation can still be important. Zinc oxide can be prepared in several ways, and when used in browns, can give different shades. These facts emphasise the need for controlled methods of preparation if consistent colours are to be obtained.

It is seldom good policy to buy the cheapest raw materials available. They often contain impurities which impair the final colour. Thus traces of nickel in cobalt compounds sometimes lead to blues which are lacking in brilliance, since nickel compounds tend to give brownish tints.

Needless to say all weighings must be done accurately by a responsible member of the staff.

Mixing

The better the mixing the more consistent is the resulting colour. This is often done either in a mechanical mixer, or by heaping the ingredients together and passing through a coarse lawn, but wet grinding followed by drying and lawning is preferable. Where it is possible to mix by chemical precipitation this gives even more intimate mixtures. Thus mixtures of oxides, *e.g.* iron and manganese oxides can be obtained by adding an alkali to a mixture of the water soluble compounds of the metals concerned. Chromium is sometimes introduced into a colour mixture as a solution of potassium dichromate, and this gives very good mixing with the other ingredients.

Calcination

This is an extremely important phase of the preparation. Generally the rule is to calcine to as high a temperature as the colour will stand without decomposition or vaporisation. Among other things calcination:

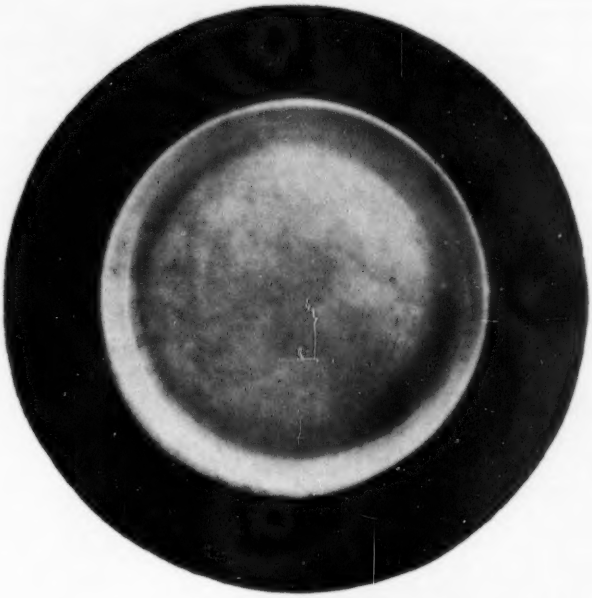
(a) brings about chemical reactions forming coloured compounds;
(b) removes combustible impurities such as carbonaceous material;
(c) decomposes certain compounds which give off gases on heating such as carbonates, sulphates, chlorides and some oxides;
(d) renders compounds such as oxides chemically inert.

Reasons for Calcination

It is particularly important to drive off all gases from colour mixes, since if this is not done they may in subsequent use give blistering of the glaze. Thus whiting decomposes giving carbonic acid gas, while cobalt and manganese oxides can change into other oxides with oxygen evolution:

$$MnO_2 \rightleftharpoons MnO + \tfrac{1}{2}O_2$$
$$3Co_2O_3 \rightleftharpoons 2Co_3O_4 + \tfrac{1}{2}O_2$$
$$Co_3O_4 \rightleftharpoons 3CoO + \tfrac{1}{2}O_2$$

Hard calcination converts these oxides into inert forms. If not done properly this oxygen can bubble through the glaze and may cause blistering. In the case of manganese glazes the gas evolution can cause "white spot" while with cobalt oxide the oxygen can sometimes cause the colour to be blown off one article on to the next, giving what is



Striking of Cobalt Blue

called "striking" of the colour.

Chemical inertness is also desirable in colours since otherwise they may be excessively soluble in the glaze, and the colours may run. Cobalt blues are very prone to this fault.

Grinding of Colour

This is done either in a colour pan with granite or steel rollers or, preferably, in a ball mill. The grinding is done wet and with certain colours there is sometimes trouble with setting on standing.

Running of Cobalt Blue

This tendency is overcome by keeping the pint weight high and using an "anti-set" such as starch, gum or dextrin, to help suspension, or by coagulating the colloid particles with calcium chloride solution.

There is as yet no agreed standards for grain size in grinding colours. The usual requirement is that it must all pass through a 300's lawn. Correct grinding of colour is important. Underground colours are gritty and do not work up well in oil. When put on ware they may give an unpleasant yellow halo around the green. Among the ingredients of the calcined mixture are lime and potassium dichromate. Calcium chromate is formed as a product of the reaction, and unless this is removed it will dissolve in the glaze giving a yellow stain or "halo." Washing with hot water, or preferably dilute acid such as acetic is resorted to, to remove the unwanted chromate.

So far we have considered the preparation of the actual colour or

Glazed tile showing "White Spot" in Manganese Brown

leave nodules which may also cause streakiness in banding. Overground colours on the other hand tend to be dusty and the glaze sometimes does not take well over them. This can sometimes cause crawling of the glaze.

Washing of the Colour

Washing is most important since calcination may produce unwanted compounds which are soluble in glazes making unpleasant haloes around the coloured pattern. Thus incorrect washing of Victoria green, a colour made from chromium oxide,

stain. In order to fix it to the ware it is necessary to add a flux to it. The flux is a fusible glass whose purpose is to melt around the colour grains and fix them to the biscuit or glazed surface, or in the case of glass, to the surface of the glass.

It also protects the colour when applied on glaze, and develops the brightness or gloss of the colour. It is well known that coloured objects appear brighter when viewed under plate glass or water, and the same applies to a glaze, which after all is a kind of glass.

With under - glaze colours the

function of the flux is to fix the colour, so that, after the oils have burned out in the hardening-on process, the colours are not washed off in the dipping.

Effects of Incorrect Fluxing

If however, the flux is too fusible or "soft" or, alternately, the proportion used is too high then it can melt too much in the hardening on and produce vitreous patches over the colour, on which the glaze will not take. On the other hand a flux which is too hard (*i.e.* melting point too high) will not fix the colour to the ware adequately, and it may shell off. It addition since it will not fuse around the colour particles properly they will appear dry and lacking in brilliance.

With under-glaze colours the shelling off may take part of the glaze with it, and on-glaze decorations often appear dry and feel rough when the flux is too hard to allow the colour to fuse smoothly into the glaze. Use of too much or too fusible a flux with under- or on-glaze colours promotes running of the colour. There is thus a difference in the fluxing of on- and under-glaze colours. The former must be fusible at enamel kiln temperatures, to such an extent that the colour melts into the glaze, while the latter needs to be less fusible, or running of the colour may result.

Use of on-glaze colours under glaze can result in some of the faults enumerated for the use of too fusible a flux in under-glaze colours, while under-glaze colours used in glaze produce dry impoverished effects which adhere poorly. It is thus evident that fluxing is a job for a specialist.

Materials Used for Fluxing

Various recipes have been given for fluxing colours. Generally speaking the amounts required for under-glaze are less than for on-glaze colours and they are also less fusible.

Under-glaze fluxes suggested are:

(a) glost pitchers or mixtures of pitchers and stone;
(b) mixtures of stone, felspar and flint;
(c) mixtures of borax and flint;
(d) mixtures containing glass;
(e) a little glaze added to the colour;
(f) mixtures containing lead, borax and flint similar to the No. 8 flux used for enamel colours.

As examples the following have been described by C. F. Binns (*Manual of Practical Potting*, London, 1922):

1. 11 lb. borax;
   9½ lb. flint.
2. 14½ lb. flint glass;
   13 lb. sand.
3. 8 lb. red lead;
   1 lb. borax;
   4 lb. flint.

For enamel colours a softer flux is needed. One commonly used is the No. 8 flux which is a mixture of flint 1, red lead 3, borax 2. This may be used up to about 80 per cent. in the colour mixture. It is, on occasions, used as a flux for under-glaze colours but in much smaller amounts of the order of 10 per cent. Other on-glaze fluxes recommended are mixtures of red lead, flint glass and boric acid, or borax such as:

(a) red lead 10;	(b) red lead 11;
flint glass 9;	flint glass 2;
borax 6, or	boric acid 4.

Special Fluxes

It has already been mentioned that some colours need a special flux. This is because the ordinary fluxes either react with them to the detriment of the colour or because the colours need the addition of a stabiliser. Thus selenium reds, which are double compounds of cadmium sulphide and cadmium selenide, react with lead compounds in the flux, forming black mixtures of lead sulphide and selenide.

The flux used therefore is usually leadless, *e.g.* sand 34, borax 29, fluospar 14, cryolite 6, soda ash 15, nitre 2, to which is added a proportion of selenium red to colour it. Sometimes small amounts of lead compounds are present in the flux if a certain amount of darkening of the colour can be tolerated. This colour, of course, can only be used on glaze. On the other hand coral reds derived from basic lead chromate, which again are only used as enamel colours, need a lead flux to preserve the colour.

There are other colours which are only stable in the presence of lime. An example of this is chrome-tin pink which for use under glaze is fluxed with a mixture of which the following is typical: 21 lb. earthenware pitchers, 3 lb. whiting, 7 lb. stone. Borax fluxes are of no use with pinks. It is well known that borax tends to cause purpling of chrome-tin pinks.

The flux can at times be used to dilute the colour, especially in the case where pitchers are used.

It can be seen that fluxing is an extremely important part of the colour makers art—it must be suited to the colour and the temperature of firing. There is no universal flux, and on occasions variations in firing conditions, from one works to another have necessitated alterations in fluxing of colours.

Future Developments

It is probable that the future will see increased attention paid to the following phases of colour manufacture.

Firstly the firing is still done in some places by loading the mixtures into saggars and firing in intermittent ovens. This will probably gradually be replaced by firing under more closely controlled con-

ditions in modern ovens, which will be gas or electrically fired. Drying is now done in many places on aluminium trays heated in ovens and this is likely to be more widely adopted. Cylinder grinding is now becoming universal for colours, and some control of grain size will undoubtedly become more widely adopted.

CHINA CLAY COUNCIL

FOLLOWING a recommendation of the China Clay Working Party a representative council, to be known as the China Clay Council, has been set up for the industry. This Council is being established on a non-statutory basis and is a tripartite body with an independent chairman and one independent member nominated by the President of the Board of Trade. Five members nominated by the china clay producers and five nominated by the Transport and General Workers' Union complete the Council.

The object of the Council according to the agreement which establishes it and signed on behalf of the two trade associations (the China Clay Association and the British China Clay Producers' Federation), together with the producers and the Union, is to advise the parties on methods designed to increase efficiency of productivity in the china clay industry and to improve or develop the services that the industry renders or could render or to enable it to render such services more economically.

The following have been appointed to be members of the Council: Chairman: Lt.-Col E. H. W. Bolitho. Independent member: Mr. A. R. Davies. Representing the china clay producers: Mr. T. G. Cunane, Mr. J. P. Goldsworthy, Mr. E. L. Joste, Sir John Keay and Mr. John Taylor. Representing the workers: Mr. Dick Grose, Mr. Harold Lobb, Mr. H. R. Priday, Mr. Alvin C. Rendle and Mr. W. H. Stone. Mr. A. W. Stamp, Board of Trade, Regional Sub-office, Plymouth, is acting as secretary pending the formal appointment of a secretary by the Council.

GAS ENGINEERS VISIT GIBBONS BROTHERS LTD.

THERE was a large muster of members of the Midland Junior Gas Association for the visit to the Dibdale and Lenches Bridge works at Lower Gornal of Gibbons (Dudley) Ltd., and Gibbons Bros. Ltd., on 26th October, in response to an invitation from the directors of these associated companies. The new tunnel kilns for firing refractory specials at the first-named works were inspected early in the afternoon, and the second part of the visit was to the engineering shops of Gibbons Bros which are in process of considerable extension and some distance away from the refractory works.

On arrival the party was received by Mr. Eric Gibbons (a managing director), Mr. Norman Van Marle, junior (son of another managing director), and by the heads of departments. Following the tour of inspection, the visitors were entertained to refreshments at the works canteen.

Continuous Tunnel Kiln

The continuous tunnel kiln (see CERAMICS, April, 1950), is one of the most up-to-date installations of its kind. It has been in full use since the summer of 1949, and its size and efficiency are alike impressive. It was designed and constructed by the associate company, Gibbons Bros. Ltd., who specialise in this kind of work. Actually, it is the largest in this country turning out fire brick shapes, which are used in the associated firm's furnaces. Fuel consumption is about 36,000 c. ft. of gas per hour.

The kiln comprises a three-bay building, which has a tunnel dryer 160 ft. long, a tunnel kiln 310 ft. long, two loading tracks, two unloading tracks, and a rubber belt conveyor for transfer of fired goods from the unloading tracks to the various sections of the stocking bay. An electric truck capable of carrying 2 tons conveys unfired shapes from the adjoining moulding floors to the loading bay; these shapes being sufficiently dry to enable them to withstand setting on the kiln trucks without squatting. The range is from small tubes to 8 in. thick specials up to 155 lb. in weight. The weekly production is 207 tons burnt weight.

Operated by One Man

The kiln trucks, which are of fabricated steel, are 9 ft. 10½ in. long and 6 ft. wide; the load carried being 5 ft. wide by 5 ft. high, and set directly on the brickwork of the truck. A truck load enters the kiln every 5 hr. 15 min. and propulsion through the kiln is by a continuously moving hydraulic pusher. The loaded trucks have an average weight of 12 ton, and these are electrically driven and fitted with powerful winch gear for moving trucks into and out of the dryer and kiln. Trucks are moved along the four tracks by twin-cable haulage gears, and complete mechanical handling makes it possible for dryer and kiln to be operated by one man only.

The dryer has a drying cycle of 84 hours and is worked entirely by clean hot air recuperated from the kiln cooling zone. A recirculating circuit, fitted with a fan handling moist exhaust air, ensures satisfactory control of the temperature-humidity cycle. The goods leave the dryer absolutely dry at 100° C.

At the reception, given on conclusion of the tour, in the works canteen. (Left to right) Mr. N. Van Marle, Gibbons Bros. Ltd.; Mr. H. J. Reynolds (secretary Midland Junior Gas Association), Mr. J. Palser (president Midland Junior Gas Association), Mr. E. B. Gibbons, Gibbons Bros. Ltd.; Mr. R. B. Watkins

no time is lost in transferring them to the entrance air lock of the kiln, which is maintained hot by recirculation of hot air from the the cooling zone. This air lock is isolated from the kiln tunnel while the trucks are being transferred by means of a flexible roller shutter, in order to avoid the loss of kiln draught so long as the kiln door is open.

To secure complete combustion of the high percentage of carbonaceous matter in the fire clay, the kiln is worked with an extended preheating period from 900°-1,000° C.; the atmosphere is maintained at a high oxidising level throughout the length of the kiln. There is a battery of 30 burners in the kiln, all being supplied with washed coke producer gas from a fully duplicated Gibbons-Heurtey producer plant. These producers are of the self-steaming type, fitted with coke elevator, conveyor and bunker gear. The consumption of coke is 33-34 ton per week, with an output of 225 tons of refractories.

The burner system is supplied with hot air under pressure from a fan drawing it directly from the kiln cooling tunnel, and further preheating this air by passing it behind a heating panel set in the rapid cooling zone.

Two sets of Phillips's high temperature recirculators, with heat-resisting alloy fans and aluminised ducts, ensure good heat distribution in the preheating zone, in the region of 450°-650° C.

The main zone is constructed in 95 per cent. silica brick, and designed for a temperature of 1,500° C. if ever required. Provision has also been made for firing with liquid fuel, if desired.

The goods are fired to Seger Cone 12, on a 157 hour cycle and the uniformity of firing is remarkably

good for all sizes and types of specials. Although only manually controlled, the kiln runs with perfect consistency and requires but little attention. Burnt losses from all causes run regularly at ½ per cent.

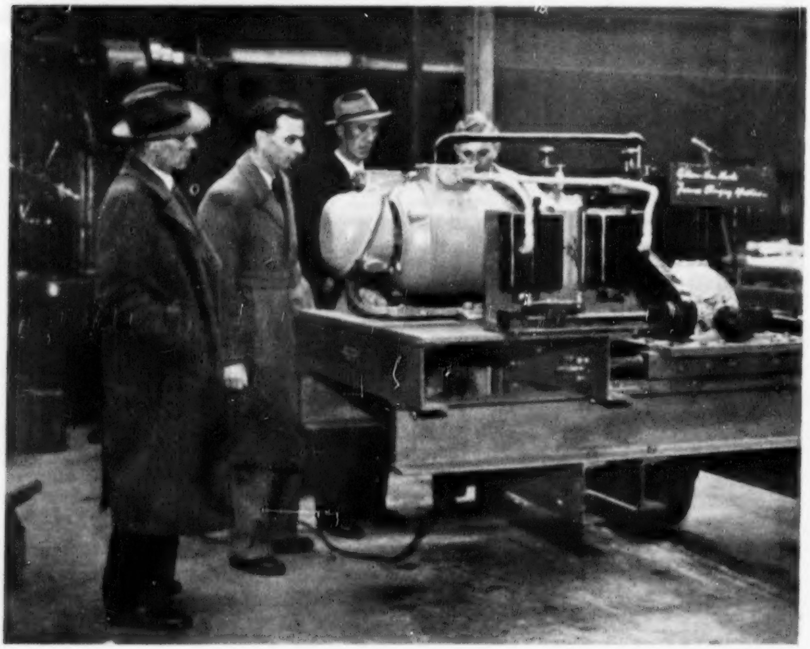
Cooling of the goods takes place in 38 hours, and is carried out in a cavity panel section, the tunnel of which is supplied with cold air by a large fan. Hot air for the dryer is tapped off from the cooling zone and the cavity walls, passed over the main arch of the kiln and blown to the dryer. The cooling zone of the kiln is so efficient that the goods come out at little more than atmospheric temperature, and can be handled immediately.

An interesting provision is that of a spacious under car tunnel, 95 ft. long under the high temperature section of the kiln, primarily for use in the event of movement of truck load. This is particularly useful for checking the behaviour of truck-running gear at maximum temperature, conditions of sand seal, and other vital points.

The tunnel kiln has the following advantages over the periodic kiln: fuel consumption is 4 cwt. plus 70 h.p. compared with 14 cwt.; the labour ratio is 1 compared with 2; percentage waste 1 instead of 3, time is only 10 days against 30 days, and cost ratio is 1 as opposed to 1·75; the product is more uniform, there is continuity of production; and the working conditions are cleaner and healthier for the operative.

Inspection of Works

Great interest attached to the extensive and varied engineering works of Gibbons Bros. Ltd., which is being improved enormously by new construction and equipment. Recent additions have been an up-



Midland Junior Gas Association members inspecting a Gibbons-Van Marle charging machine at the Lenches Bridge Works

to-the-minute and extensive pattern shop, well lighted and partly equipped with the most modern mechanical aids, with other machines due to arrive at short intervals, and an adjoining pattern stores—a new feature—separated from the pattern shop by a section of the 20 ft. roadway which runs all round the works. To reach the new foundry, one passes a strip of this roadway; it is hoped to have the foundry in operation in the early part of December.

The New Foundry

The main shop of this foundry is 250 ft. by 50 ft.; the core shop is 94 ft. by 35 ft.; the light foundry 90 ft. by 35 ft.; and the cupola bay 42 ft. by 70 ft. There are two cupolas, one with a capacity of 5 tons and the other of 1½ tons per hour. These are remote controlled, charged mechanically by means of a 1½ ton electric hoist, fitted with bottom opening scoops. One core circulating stove is 2½ ft. by 10 ft., and the other 25 ft. by 20 ft.; they are time controlled and automatically operated.

The main foundry has an overhead travelling crane equipped with 10 and 5 ton cranes. The core shop has a 3 ton floor operated crane. The core stoves have a capacity of 70 tons of cores in a 12 hour period. A sand circulating system minimises wastage of sand, as it enabled the sand left over from one operation to be returned to the moulders, and while it is being whirled back all tramp iron is screened out of it. The backing sand plant for the main foundry has a capacity of 15 tons an hour, and the facing sand in the machine moulding section of the light foundry one of 7½ tons per hour.

The whole of the constructional work is carried out by direct labour employed by the firm. There is a small army of bricklayers, about sixty being used in the works, and between 400 and 500 on outside contracts in all parts of the world where the company send and erect furnaces and kilns. The output capacity of the new foundry will be 200 tons per month, compared with 100 tons from the existing one. There is plenty of space for further extensions.

There are two stockyards, one for steel, serviced by 5 and 10 ton cranes respectively. The main steel shops have four 5 ton cranes and one 10 ton crane, and there are electrically driven machines for feeding and emptying furnaces.

The works is served by railway lines. The main line passes at a higher level a few yards outside, and from this a loop is carried on a level with the works floor. On to this loop line trucks are run which are emptied and refilled in the shops before emerging at the other end of the loop, preparatory to resuming their place on the main line. Trucks laden with heavy material are unloaded outside by means of the 10 ton travelling crane.

Each section of the works has its own administration offices, which are controlled from the works head office. Additions to the works in course of completion are heated locker rooms in which employees can change their clothing at the end of shifts, and adjoining these are shower and foot baths and conveniences. There is also a well-equipped medical and first-aid centre.

Extensive Exports

The visitors were able to see quantities of products, some completed, some nearing completion, others semi-finished, to fill orders from a number of gas undertakings of this country. The firm also exports extensively to most parts of the world—practically to all Europe outside the Iron Curtain, and even to Russia; and to Africa, Australasia, South America, India, Ceylon and Gibraltar. The management, as will be inferred, take an interest in their employees and encourage

their efforts in various ways. One instance may be cited: the employees in the works were informed that each one of them earns enough foreign exchange to pay for the rations of thirty-five persons in the United Kingdom!

Mr. Palser Thanks the Directors

It was well after dusk when the last group came in to enjoy the liberal refreshments provided. In proposing a cordial vote of thanks to the directors of the two organisations, Mr. J. Palser (Association president) said the management might be interested to know that the attendance was a record, and referred to the previous visit 15 years ago almost to a day when they saw a series of bottle kilns at the Dibdale works. Most of these had now been replaced by that masterpiece, the continuous tunnel kiln, although it was still necessary to use certain bottle kilns for particular types of work.

Mr. Palser next remembered that the company was unique in so far as they made the plant which produced the gas and also the plant which used this gas, and it would be very interesting if figures were available of how much gas was manufactured at the works and how much was consumed by the plant installed to use it.

Example of Enterprise

Mr. Palser also alluded to the original conglomeration of engineering shops and the new works built at Lenches Bridge, and to the very fine section now mainly devoted to the manufacture of gasworks plant. It was a cheering example of what an enterprising and go-ahead concern could do in the way of expansion and development, and they were all indebted to the directors and management for providing them with such an interesting and instructive afternoon, and for entertaining them so hospitably.

Mr. R. B. Watkins (Coventry) seconded as senior vice-president; and mention was made of the services of Mr. Norman Van Marle in being responsible for making the arrangements for the visit. Mr. Eric Gibbons acknowledged the vote, saying they were pleased to welcome the Association again now that the task of works reconstruction had proceeded so far, and before concluding gave a few approximate figures in reply to Mr. Palser's question on gas production.

Brief History of the Gibbons Firms

The Gibbons family lived in Sedgley, Staffordshire, the parish in which Gibbons works is still situated, from early times, and from about the year 1720 a junior branch were carrying out business as ironmakers and merchants.

In the year 1834, Mr. Benjamin Gibbons of this branch, having found a good fire clay on his property, founded the firm of B. Gibbons, Junior, to make fire clay goods for the gas industry, just then commencing to develop. In 1844 Mr. Gibbons had four kilns and factory buildings covering 4,700 sq. ft. It is believed that certain gas companies have been regularly supplied with their fire clay goods ever since that time.

Mr. Gibbons died young, and the business was afterwards owned and managed by his widow, Mrs. Emily Gibbons, assisted by her two sons, Benjamin and William Pike. Under their management, it commenced to develop rapidly. Patents were acquired for manufacturing gas retorts by machinery and for many years the production of these was the most important activity of the old firm, output reaching over 100,000 ft. per year before the outbreak of the 1914 war.

In the 1870 decade, Mrs. Gibbons' sons, while continuing to manage the firebrick works, founded a small business of their own to supply sundry items in iron to gasworks which soon developed into

contracting for resetting work, etc. With the aid of Mr. Edward Masters various improved forms of retort setting, generators and regenerators were invented and by 1894 Gibbons Bros. had developed into a considerable business. A private company was then formed, small premises in Dudley were later vacated and engineering shops built adjacent to the firebrick works. At the same time, Benjamin Gibbons was made into a private limited company. Mr. G. B. A. Gibbons, who had been manager for the Liverpool Gas Company, joined the firm a little later in the place of Mr. Benjamin Gibbons.

Important Contracts

Up to the outbreak of the first world war, Gibbons Bros. continued to develop their contracting side rapidly, opened branch offices at London, Manchester and in Australia, and carried out important contracts for horizontal and inclined retort systems in most countries of the world.

In the same period, the construction of furnaces for the metallurgical industry was commenced. During the first world war this side of the business developed very rapidly and many important furnace plants were supplied, particularly for the annealing of cartridge cases, shell cases, and brass and copper articles generally.

In 1919, the two firms were amalgamated and a public company was formed under the name of Gibbons (Dudley) Limited which company owned and still owns Gibbons Bros. Ltd. The first world war had retarded gasworks construction and renewals, so that during the first few years of the peace, Gibbons were busy again on gasworks construction. To meet the heavy demand of this time, a foundry was purchased and new structural steelwork shops were built.

By 1925, the demand for new

carbonising plants having somewhat slackened off, it was necessary to branch out further to keep the extended works going to full capacity. Accordingly, the furnace business of Harvey Siemens was purchased in 1925, the ceramic tunnel kiln business of Dressler Tunnel Oven Company in 1927, and rights were acquired to construct the Kogag coke oven in this country. In 1926, Mr. W. P. Gibbons had died and Mr. C. H. Bennett and Mr. T. Allen became joint managing directors of the company—Mr. Allen being sole managing director during the 1930's. As a result of the new developments referred to, the company came through the bad period from 1929 to 1933 without undue strain, and up to the outbreak of the second war continued to develop rapidly, the business in ceramic tunnel kilns proving a particularly satisfactory development. The company were the first to introduce the use of town's gas as the fuel to fire these ovens. This proved perhaps the best answer to the problem of firing pottery and is now generally adopted.

During the second world war, the company's activities were again largely centred in the construction of furnaces for the munitions industry. Practically every one of the new explosive plants built in the country were supplied, as well as numerous factories in the aircraft, armour plate and other war industries.

The post-war period is again proving one of rapid development with much work on carbonising plants, on ceramic tunnel kilns, and generally. Complete new machine shops and large new structural steelwork shops have been built, and a new foundry is now nearing completion. Equally important extensions are being carried out on the refractory side of the business.

A STUDY OF DRYING

Institute of Fuel Lectures

UNDER the auspices of the Institute of Fuel, a programme of lectures has been arranged under the following headings:

(1) Fundamentals of Drying.

(2) Current Drying Practice and Instrumentation.

(3) Drying in the Textile, Paper and Allied Industries (e.g. cotton, rayon, fabrics, wool, jute, rugs, silk, hemp, laundry, paper).

(4) Drying in the Clay Industry (e.g. pottery ware, clay ware, china clay, filter cake, bricks, tiles).

(5) Drying of Pastes, Powders and Crystals (e.g. barytes, cryolite, white lead, sewage sludge, bauxite, kieselguhr, pigments, dextrin, gypsum, phosphates, dyestuffs, milk, soup, egg, coffee extract, whey, lactose, starch, brine, nitrates, carbonates, borax, alums, sulphates, tartrates, sugar, chlorides, metallic salts).

(6) Drying of Fuels, Sand, etc. (e.g. coal, coke, lignite, peat, sand, ores, aggregates, rock).

(7) Drying in Agriculture and Forestry (e.g. grass, lucerne, sugar-beet tops, sugar-beet pulps, kale, hops, flax, wheat, barley, oats, seeds, malt, herbs, seaweed, timber, sawdust, tea, dehydration of food).

(8) Drying of Animal By-products and Miscellaneous (e.g. leather, bonemeal, fishmeal, slaughterhouse waste, fish offal).

(9) Final Conference.

The first papers were presented in London on 5th December, 1950, at 5.30 p.m. at the Institution of Chemical Engineers, Storey's Gate, St. James's Park, S.W.1, dealing with "Some Fundamental Aspects of Air Drying of Solids" by R. Hendry and A. W. Scott; "The Determination of Moisture in Coal" by E. G. Barber; and "Methods of Estimating Moisture" by A. H. Ward.

Thence papers will be presented throughout the various Regions, concluding with a Conference in London in April, 1951.

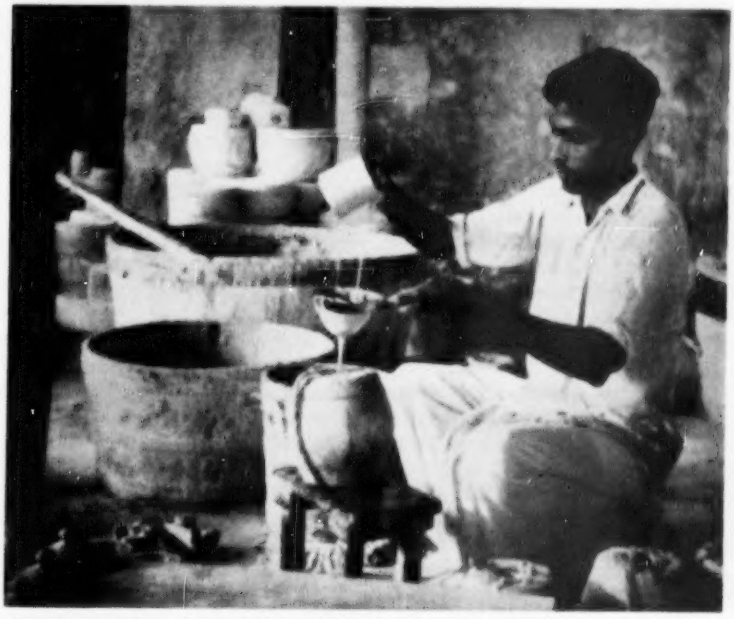
Those interested in attending the Conference or contributing to the discussion should get in touch with the Secretary, The Institute of Fuel, 18 Devonshire Street, Portland Place, W.1.

GLASS AND CERAMICS IN INDIA

by

B. L. MAJUMDER, M.Sc., A.M.Inst.F.

THE beginnings of pottery in India are lost in antiquity. The art was perhaps an independent invention of the primitive people in different parts of the world and in India this is testified by the mention of pottery in the *Vedic hymns* and archæological findings in caves and graves. The *laws of Manu* codified in the 9th Century B.C. how metal or earthen vessels, polluted accidentally, should be purified. Objects found in the recent excavations of Harappa and Mohenjo-daro in the Indus valley are closely connected and roughly contemporary with the Sumerian antiquities dating from the 3rd or 4th Century B.C. There are also numerous examples of personal clay seals bearing the names of persons and institutions from about the 2nd Century B.C. to A.D. 600 References in the literary manuscripts of Pliny, the Roman historian and others indicate that glass was being manufactured in India centuries before the age of Christ. The first Indian references to glass are in the Mahavansa, the chronicles of the Sinhalese kings (306 B.C.) when glass mirrors were carried in processions.



An operative in a Travancore ceramic factory is seen filling up a mould with semi-fluid clay. Photo by courtesy of H. E. the High Commissioner for India

In Punjab, the manufacture of glazed pottery dates from about the period of Chingiz Khan (1206-1227). Hyderabad in Sind owes this art to the Chinese who were induced by one of the *Amirs* to settle in that district.

Early Indian Terra-Cotta

Earliest examples of Indian terra-cotta, both in the Indus valley some 5,000 years ago and in the Mauryan period about the 3rd Century B.C. were hand-modelled. Moulds were evolved in the 2nd Century B.C. and the techniques of casting were employed effectively for about 2,000 years. They became very popular in the Gupta period and present a rare assemblage of all decorative designs then in vogue—amongst the figures, gods and goddesses—both Brahmanical and Buddhist — appeared predominantly. Enamel decorations on bricks are believed[1] to have been developed between the 5th and 11th Century and specimens of glazed tiles after the Persian style were unearthed during the excavations of Gour, a seat of Mohammedan kings of Bengal between the 11th and 13th Century.

Evidence of Social Life

The arts and activities of the potters have through the ages maintained a working evidence of social life, popular beliefs and forms of folk culture and they furnish a surprising continuity from the days of Indus valley to the present times. A section known as *Kumhars* in Bengal have followed this occupation hereditarily as an indigenous cottage industry and the main items of their activity are clay figures and earthenware vessels of all descriptions. Their creative skill in designing and decorating the clay figures of gods and goddesses on the occasions of many Hindu festivals are to be greatly appreciated.

In India, large numbers of people use earthenware vessels for their cooking as well as drinking utensils mainly for economic reasons and religious background. Apart from the vilage potters (*Kumhars*), there are many agricultural families throughout the country found to be engaged in making pottery as a secondary means of their livelihood.

Pottery Making

The actual shaping of pottery is apparently confined to the women who have learnt the art from their mothers and other elder women of their households at a very early age (12 to 14 years), while the men only help them by bringing suitable clay from the bank of the river, firing the kiln and selling the pots in the local markets. Some of these families, e.g. those belonging to the *Kshatriyas* by caste, preserve the prestige of their own caste by not using the wheel[2] in shaping their pottery. The implements they use for making pots are very simple and the absence of the wheel does not seem to stand in the way of making pots on a commercial scale.

Fundamentals Unchanged

The fundamentals of pottery making have not changed from the beginning. Attempts to make ceramics a science instead of an art in the European countries have only introduced certain refinements in technique, firing, etc., and in the better control of raw materials and qualities. The application of these refinements in the manufacture of white pottery in India dates from 1860 when the deposits of china clay were found in the Rajmahal Hills and a pottery flourished at that time near Colgong in Bhagalpur district. The next pottery run on the same lines was started in Calcutta during the early part of the present century and since then a number of other factories have been established in different parts of the country. The products of these factories cannot, however, compare favourably with those manufactured in other countries, particularly England and

America. The development and production of porcelain and industrial ceramics are still in infancy.

The Glass Industry

Though the glass industry in India was established in the 16th Century, the production consisting of cheap bangles and small bottles was on a cottage industry scale mainly in the Ferozabad area in the U.P. till the end of 19th Century. The first regular plant for glass manufacture was established in the nineties of the last century at Jhelum in Punjab by the Murree Brewery. This was followed by the establishment of a number of other factories but most of them went out of work at an early date because of the lack of enlightened management and expert guidance.

With the introduction of factory scale manufacture of bangles, the cottage industry has had to struggle hard for its existence. The factory industry is turning out much better bangles and has considerably reduced the total imports to less than 1 million pounds in 1940-41 from the imports totalling over 3·7 million pounds in 1929-30. There are now 174 glass factories manufacturing a very wide range of articles extending from bangles at one end to scientific glass instruments at the other. A total annual production of 153,450 ton of glass meets about 80 per cent. of the country's demand.

Government Assistance

It soon became evident that the governmental assistance in the shape of technical assistance was imperative if the industry were to meet the growing demand for articles, both in quality and quantity. The Government also became aware of the fact that the economic and social well-being of a nation, in this modern age, depends largely on the industrial utilisation of the results of researches in science and technology. In fact research facilities for glass and ceramics in India were recommended as early as 1918 when the Indian Industrial Commission suggested the setting up of a Research Institute.

Prior to the last war, however, organised scientific and industrial research under Government auspices received such little attention as to prove hopelessly inadequate. The problems of the supply and development of war materials created by the Second World War brought home the need for a strong central research organisation and the Board of Scientific and Industrial Research was set up by the Government in 1940. This Board gave way, in1942, to the present Council of Scientific and Industrial Research, an autonomous registered body. Later in June, 1948, a separate Department of Scientific Research was established directly under the charge of the Prime Minister, Pandit Jawaharlal Nehru, with Dr. S. S. Bhatnagar as its secretary.

Scientific and Industrial Research

The new era of the rapid development of scientific and industrial research soon followed with the establishment of eleven National Laboratories and Research Institutes under the Council of Scientific and Industrial Research and during 1950 the first five of these laboratories have been opened. The Central Glass and Ceramic Research Institute, fourth in these series of laboratories, was opened by Dr. B. C. Roy, West Bengal Chief Minister, at Jadavpur, Calcutta, on 26th August, 1950. The objects of the Institute are manifold. It will conduct fundamental research having a bearing on different phases of glass and ceramics. Another main function of the Institute will be to render technical help to the industry in the improvement of the quality of products and to induce the industry, by demonstrating the benefits of scientific processes, to utilise and adopt improved techniques and work operations.

The Institute is fortunate in securing the services of Dr. Atma Ram as its Joint-Director. He has been a real constructive spirit behind the Institute, as the plan and organisation of the Institute is largely due to his initiative and single-minded devotion to work and intimate knowledge of the Indian glass industry. Dr. Atma Ram first joined the Alipore Test House as an employee of the Industrial Research Bureau after a brilliant career in Physical Chemistry at Allahabad. While at the Test House, he often had to visit the glass factories in Calcutta to find out the difficulties from which they were suffering and this led him to an intense study of science and technology of glass. Later, his contribution to glass was recognised by his election as a Member of the International Commission on Glass from India. He has also increased his knowledge by extensive tours in England, Germany and America.

The New Building

The Institute will be housed in a three-storeyed structure but for the present two storeys have been built. It comprises two blocks — the main building and the technological block. The laboratories for precision work, the library, the museum and offices are in the main building; while in the technological block with a floor space of 15,700 ft. are located the enamel laboratory, store rooms for raw materials, and rooms for workshops and experimental furnaces. It is also equipped for processing and beneficiating raw materials, particularly glass sands. A collection of raw materials and finished products including some rare specimens are exhibited in the museum of the Institute. Historical objects from Mohenjo-daro, Harappa and glass belonging to the Moghul, Napoleonic, pre-Victorian and Victorian periods have been lent to the Institute by Shri Jethia Maharaja of Burdwan and various other collectors of antiquities.

Work Undertaken

The construction of the technological block of the Institute commenced in 1945 and technical work has been going on there since 1948. Investigations for improving the quality of raw materials by treatment such as washing, magnetic separation have been pursued in the Institute since 1948 and already very substantial contributions have been made by Dr. Atma Ram and his able colleague Mr. Y. P. Varshney who has specially been in charge of the furnaces. Fundamental studies on the properties of the raw materials used in the glass and ceramic industries have also been undertaken: work is also going on in the study of talc available in India; results have been obtained on the subjects of coloured glass, foam glass and sintered glass filters.[3] A section for making refractory parts has also been organised and it is proposed to conduct trials on slip casting pots required in the manufacture of optical glass.[3]

The foam glass has aroused great interest on account of its special buoyancy and thermal insulation property. Sintered glass filters of the whole range of porosities required for chemical and bacteriological work can now be produced on a pilot plant scale. Work has been carried out specially with a view to manufacture these filters on a large scale with Indian raw materials and machinery. The resistance glasses manufactured by several Indian glass manufacturing firms have proved quite satisfactory for the manufacture of these filters.

Optical Glass

Though the quantity of optical glass produced is a very negligible fraction of the total annual production of glass, its importance as the vital components of telescope, microscope as well as the optical systems of the tank, anti-aircraft

guns, submarines, etc., overshadows most of the other types of glass in importance.

No Organised Effort

During the last war, considerable work in the processing of optical glass, such as, grinding, polishing etc., was done at the Mathematical Instruments Office, Calcutta, and the Survey Office Laboratories at Dehra Dun but there has been no organised effort to establish the industry in India. Some scientific investigations have recently been carried out under the auspices of the Council of Scientific and Industrial Research and now a special responsibility rests on the Joint-Director of the new national laboratory to ensure the production and development of optical glass because of its strategic importance for the defence of the country. Dr. Atma Ram acquired considerable knowledge of its manufacture while working at the optical section of the National Bureau of Standards in America.

Acknowledgement

To broaden the scope of this report far beyond the scope of my knowledge of happenings in India, I have freely drawn several informations appearing as new and press reports on the occasion of the opening of the Institute.

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A Brief Survey of the Thermal Insulation Field

A STAFF REPORT

THE thermal insulation industry is relatively young, manufactured insulation not appearing in this country until about 40 years ago with cork board and 85 per cent. magnesia as the principal products. Since that time however, the range of materials has increased rapidly and thermal insulation has become a highly specialised technology.

Although it is comparatively rare to encounter an unsuitable thermal insulation used, it is very common to find that insufficient thought has been given to quantitative aspects with the result that equipment has been so designed that it is impossible to apply the requisite thickness, and money which should have been spent on insulation has had to be paid out repeatedly in unnecessary fuel costs. Insulation should be regarded as a necessary and vital material of construction to be carefully considered in the initial design of the plant.

Basis Principle

In general, thermal insulants are of cellular or granular structure, their high thermal resistance being due to the discontinuities in the heat-flow path of mixed solid and gaseous (usually air) phases, e.g. silica in the continuous solid phase, has a thermal conductivity of some 10 B.Th.U./in./ft.^{2}/hr./°F. but in the form of silica aerogel its conductivity drops to 0·15 B.Th.U./in./ft.^{2}/hr./°F. The large drop in the path of heat-flow being mainly across the air spaces, conduction along the thin walls of the solid matrix plays a very small part. This principle is the basis of most insulators, an exception being the "reflective" type.

Thus, in cellular insulators conductivity is roughly proportional to bulk density, though with fibrous materials, there is an optimum density giving minimum conductivity, low conductivity depending also on the size of the individual air spaces.

It is obvious that the basic matrix forming the insulator must be capable of withstanding the maximum temperature to which it may be subjected. Mechanical strength too, is a property of the solid matrix and depends on the material and thickness of the cell walls. Conductivity and mechanical strength therefore become conflicting properties, most insulators being the result of compromise.

Economic Thickness

Insulation thickness is essentially a question of economics, and a balance has to be made between cost of insulation and the value of the heat saved. The cost of maintaining a temperature differential varies with actual conditions, it being more expensive to maintain a 100° F. differential below atmospheric temperature than above it.

One of the simplest methods of determining economic thickness is that given in British Standard 1334 (1947). Costs of insulation plus the cost of the heat lost over a predetermined period (calculated for increasing thickness of insulation) have been used to plot a curve exhibiting a minimum at the economic thickness for the conditions

assumed, the cost of any expensive finishing layer being omitted from the calculation. Where steam is transmitted for power generation, thermodynamic factors may make a further increase in insulation desirable, and such cases are to be treated individually.

In the chemical industry insulation may be required quite apart from economic reasons. Many chemical reactions give an optimum yield at a definite temperature, and for economic working careful temperature control is essential.

SOME THERMAL INSULATING MATERIALS AND THEIR PROPERTIES

Organic Materials

This class of materials is almost exclusively confined to use at temperatures not exceeding about 200° F. and down to those of liquefied gases. It includes cork, hair felt, balsa wood, kapok, expanded wood fibre, expanded rubber and a large range of foamed synthetic resins. The bulk density of these materials varies from a few oz./ft.^{3} to over 10 lb./ft.^{3} thermal conductivities ranging from 0·15 to 0·3 B.Th.U./in./ft.^{2}/hr./°F. at the temperatures at which they are used.

The use of cork in refrigerated equipment is well known. It possesses good mechanical strength but, as with all low temperature insulators, must be protected from moisture by vapour seals. Failure to effect a complete seal may result in complete destruction of the insulation by ice formation.

The field of expanded resins is relatively modern and is rapidly extending; commercially available materials include polystyrene, cellulose acetate, urea-formaldehyde, calcium alginate and polyvinol chloride. These foamed resins are available in a wide range of bulk densities and figures as low as ½ lb./ft.^{3} are reported; naturally such low densities are obtained only at the expense of mechanical strength.

Inorganic Materials

The principal field of application of this class of insulating material covers the medium and high temperature ranges, i.e. from about 200° F. up to 2,400° F. There are inorganic materials, however, which by virtue of low thermal conductivity are used at liquefied gas temperatures; their incombustible nature being advantageous in insulation of liquid-oxygen vessels, where an organic material may introduce additional fire hazards. Examples are silica aerogel and light magnesium carbonate. Experiments carried out in Russia in 1945 showed that the conductivity of such materials is lowered by subjecting them to reduced pressure; readily effected by displacing the air in their structure by carbon dioxide or Freon.

Another inorganic insulator used in the low and atmospheric temperature range is crumpled aluminium foil. The resistance to heat-flow is due to the low emissivity of the polished metal, but the relatively large size of the air spaces cause an increase of convectional transfer as temperature rises, and its "conductivity" increases fairly rapidly at higher temperatures. Very low weight recommends this insulator for use in refrigerated transport; but its negligible mechanical strength demands adequate support and protection. Conductivity figures of 0·20-0·90 B.Th.U./in./ft.^{2}/hr./°F. are given.

MATERIALS USED IN THE TEMPERATURE RANGE 200°-1,200°F.

Slag Wool

This material is also known in the trade as silicate cotton, mineral wool, or rock wool. Manufacture consists of melting the slag or rock in a cupola and fiberising thin streams of the melt (by means of high-velocity steam jets) into a voluminous woolly mass.

Thermal conductivity of slag wool varies with bulk density and figures of 0·26-0·50 B.Th.U./in./ft.^{2}/hr./°F. are reported.

Vermiculite

Vermiculite is a micaceous mineral mined extensively in South Africa. Heating causes expansion of the laminæ, producing accordion-like grains of about fifteen times the volume of the original flakes. It is used as a loose-fill insulation for cavities or as a component in light-weight plasters. The thermal conductivity of loose vermiculite is of the order of 0·3 B.Th.U./in./ft.^{2}/hr./°F. at atmospheric temperature and the bulk density about 6 lb./ft.^{3} It is suitable for temperatures up to about 2,000° F.

Corrugated (or air cell) Asbestos

Air cell asbestos is composed of alternate layers of plain and corrugated asbestos paper, bonded together to give a cellular structure. Thermal conductivity varies with the number of layers per in. but figures of 0·6 B.Th.U./in./ft.^{2}/hr./°F. are quoted. The material is fairly rigid and is available in large panels (up to 3 by 8 ft.). Normally applied at temperatures up to 300° F., it finds application in the construction of drying chambers, etc.

Glass Fibres

In some respects glass fibres resemble slag wool, in that both are fiberised forms of artificially produced siliceous materials. One type of glass fibre is produced by a somewhat similar process to that described for slag wool, whilst the long fibre type is made by drawing out filaments of molten glass at such a speed that the fibre diameter is of the order of 1/1000 in. The fibres are "carded" into sheets stitched between paper or thin cloth layers or bonded with resin. Conductivity is about 0·30 B.Th.U./in./ft.^{2}/hr./°F. at atmospheric temperatures. A special type of glass fibre has recently been developed for temperatures up to 1,000° F. and silica fibres for temperatures up to 2,000° F. have been used for the insulation of jet engines.

Asbestos Fibres

For thermal-insulation purposes the principal asbestos fibres used are the yellow (amosite) and blue (crocidolite) varieties. They are felted into slabs or pipe sections or used loose as filling for mattresses. Blended fibre is used as a heat-resisting bond for kieselguhr mixes and 85 per cent. magnesia compounds.

Good commercial grades have thermal conductivities of approximately 0·40-0·50 B.Th.U./in./ft.^{2}/hr./°F. at atmospheric temperatures rising to about 0·60-0·70 at 600° F. Amosite asbestos may be used up to about 900° F.; the other types somewhat lower.

85 per cent. Magnesia

One of the earliest of manufactured insulators, this still holds a prominent place. It is composed of light basic magnesium carbonate plus 15 per cent. asbestos fibre. The thermal conductivity at atmospheric temperatures is 0·39 B.Th.U./in./

ft.^{2}/hr./°F. rising to 0·49 at 300° F. mean temperature. At temperatures above 600° F. the magnesium carbonate loses some of its combined water and shrinkage occurs. At such temperatures a heat - resisting layer of insulation is necessary between the hot surface and the 85 per cent. magnesia.

Materials Based on Kieselguhr

Kieselguhr consists of fossilised remains of minute aquatic organisms. The structure, being microporous and composed largely of silica, combines low conductivity with good resistance.

Compounds of kieselguhr and asbestos fibre are widely used in plastic or moulded forms of insulation at temperatures up to 1,200° F. It is often used as a primary insulant to protect a second layer of more efficient insulation which is itself unable to withstand the high temperatures involved.

Inorganic Materials for High Temperatures

Into this range fall materials used in furnace insulation, where the ability to withstand high temperatures without deterioration is of primary importance.

A kieselguhr-basse insulating brick suitable for furnace insulation is made by adding clay to a calcined kieselguhr. Increase in bulk density (and conductivity) may partially be avoided by incorporating in the mix a proportion of granular organic matter such as cork dust, sawdust, or coal, the combustion of which produces a large number of small voids. Such bricks are not used much above 1,000° C. and have a thermal conductivity of 1·0-2·0 B.Th.U./in./ft.^{2}/hr./°F.

By similar technique, a porous fire clay brick may be produced, whilst for higher temperatures sillimanite or kyanite have been suggested. Light weight refractories are also made by the sintering of fire clay or sillimanite grog to produce a coarse granular structure.

For monolithic insulation a number of "refractory insulating concretes" are obtained by incorporating a lightweight aggregate with aluminous cement. Aggregates include crushed insulating brick, calcined diatomite or exfoliated vermiculite. The density and conductivity of a typical mix, at 900° F. mean temperature are 70 lb./ft.^{3} and 1·8 B.Th.U./in./ft.^{2}/hr./°F. respectively.

PNEUMATIC TOOLS AND ACCESSORIES

IN this British Standard (B.S. 673: 1950) the dimensions of shanks for use with the following types of pneumatic tools are given with illustrations:

Rock drills; chipping and caulking hammers and stone tools; coal picks; demolition picks and spades; concrete breakers; and riveting hammers.

The standard includes a comprehensive series of definitions relating to rock drills; pneumatic hand tools; attachments for pneumatic hand tools and other pneumatic appliances.

Priced 3s. the above is obtainable from the British Standards Institution, 24-28 Victoria Street, London, S.W.1.

PROCESS INSTRUMENTATION

COURSES in this subject have recently been initiated by the Department of Coal, Gas and Fuel Industries with Metallurgy at the University of Leeds. The course, which will ultimately be taken by all degree and post-graduate diploma students in the subjects of gas and chemical engineering, ceramics and process metallurgy, is to be given in two parts. The first part, which has commenced in the current session, is "The Measurement of Process Variables" and deals with principles and methods of measuring such quantities as pressure, temperature, fluid flow, etc. The second part "Automatic Control" will commence in the following session and will deal with the theory and practice of automatic controls as applied to the process industries.

These lecture courses, in common with other lecture courses in the University, are open to external students by arrangement with the Department of Extra-Mural Studies.

THE SILESTER BONDING PROCESS

by

A. E. WILLIAMS, Ph.D., F.C.S.

WHAT has become known as the silester bonding process makes possible the syntheses of a whole series of silicates such as Mullite $3Al_2O_3.2SiO_2$, Forsterite $2MgO.SiO_2$, and Zircon $ZrSiO_4$, from high-quality sillimanite, alumina, magnesia and zirconia. These materials form the basis of a new group of refractory materials which are finding useful applications for high-temperature work in a number of different industries. Silesters may be considered as liquids containing 40 per cent. by weight of silica and they are very convenient alternatives to fluxes and clays, because they yield silica in a specially reactive and adhesive form.

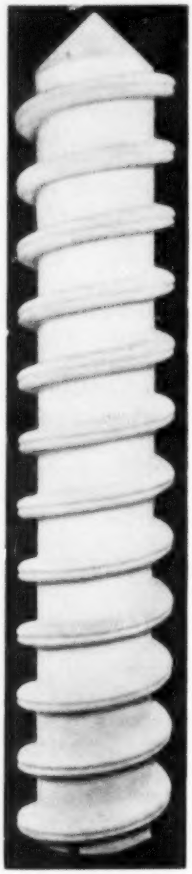


Fig. 1.
A hollow spiral worm for a flue used as an experimental tunnel by British Coal Utilisation Research Association

Advantages of Process

In the production of these new refractories, a slurry of silester liquid and water, together with the refractory filler, is poured in or around an easily made wood or plaster pattern and allowed to cold-set. After 16 hr. air drying, the product is baked. The advantages of the process may be summed up as: (1) The better qualities obtained, due to eliminating fluxes and clays by the more reactive and regularly dispersed liquid source of silica; (2) the ease with which awkward shapes may be produced in fine surface detail, with physical properties varied to suit any specific requirements; (3) the rapid production from the initial project to completion, without elaborate or expensive equipment.

Some of the components made by this process include furnace interiors, gas-, electric- or oil-fired, liners and formers for electric muffle furnaces, insulators, sleeves and inserts for low-frequency coils, burner blocks and element retaining bricks, tubes for high-temperature furnaces working in inert atmospheres, crucibles of every description, saggers to suit furnace or kiln apertures, suspension rods, furnace nozzles and orifices, pre-formed linings, open melting hearths for assay work, and also top secret work in the sphere of atomic energy, rocket and jet plane design. Some of the refractory components in these new materials, produced by Zirconal Ltd. are seen in the accompanying illustrations. Fig. 1 shows a hollow spiral worm for a flue, 7·5 ft. high by 2 ft. overall dia., which is used as an experimental tunnel by British Coal Utilisation Research Association. Fig. 2 depicts a section of a carburising furnace in which the elements are held by slotted grooves in brickwork. Fig. 3 illustrates refractory tiles to protect high-frequency coils on a rotating hearth. Moulds for foundry work are also produced in these refractories. For example, semi-permanent moulds for repetition casting of low melting point alloys, moulds for casting plastics, rubber or powder metallurgy dies in steel and other high melting point alloys.

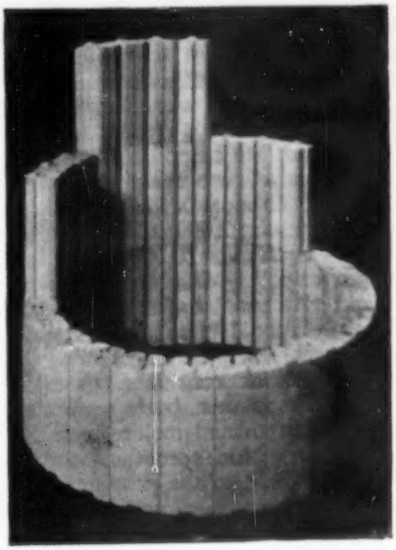


Fig. 2. A section of a carburising furnace in which the elements are held by slotted grooves in brickwork

Relatively High Properties

The properties of the refractories are relatively high, as the following data show. Crushing strength 3,000-22,000 lb./in.; electrical insulation 10·5 kV. per 0·25 in. section

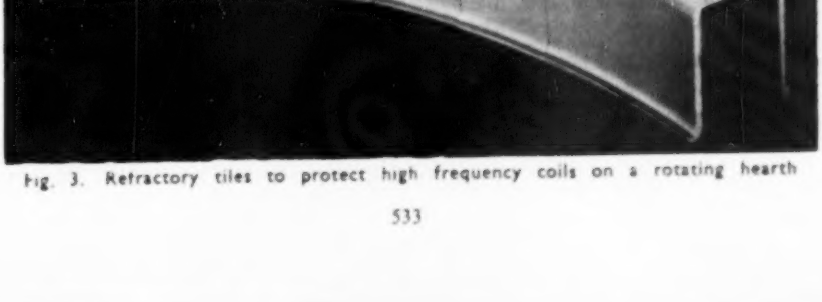


Fig. 3. Refractory tiles to protect high frequency coils on a rotating hearth

without breakdown; temperature resistance 700°-1,800° C.; crucible thermal shock test: a sample was heated to 1,750° C. in 2 min., then plunged into cold water, no damage resulted. Although most of such refractories are based on sillimanite, other products are being made. One of these, Zirconal X, has a melting point of about 2,600° C. a compressive strength over 20,000 lb./in. and possesses a 7·5 Moh scale hardness, that is, it cannot be scratched by a file. Zirconal N is a commercial grade exhibiting the same order of thermal shock resistance, chemical and slag resistance, but a somewhat lower strength and melting point.

Silesters, which are the bonding materials used in the production of the refractories, are modified forms of ethyl silicate, which is a compound of silicon, oxygen, carbon and hydrogen. They have the property of depositing extremely fine silica which finds its way into the minute interstices of the refractory filling material and binds the whole firmly together. One of the advantages of silesters over the fluxes and clays hitherto used for bonding purposes is that the silesters yield silica in a highly reactive form and it is put to use before it can resume its normal state, or become contaminated by surrounding materials. When silesters are combined with highly refractory filler materials such as alumina, sillimanite, molochite, or synthetic zircon, and subjected to heat - treatment at a temperature around 1,250° C., the resultant mass is tough and extremely thermal-shock resistant.

Synthetic Zircon

Synthetic zircon is produced by a high-temperature chemical reaction between the two oxides, zirconia and silica. The silica is contained in the bonding liquid, ethyl silicate, and the reaction depends on the very reactive nature of the silicate deposited as a result of the hydrolysis of the ethyl silicate. Pure zirconium silicate has a theoretical melting point of 3,000° C. With 10 per cent. silica and 90 per cent. zirconia, this becomes 2,600° C. Components made from synthetic zircon show good resistance even at temperatures in excess of 2,200° C.

SILICONE LUBRICANT FOR CONVEYOR IN 700° F. FURNACE

As a result of satisfactory operating service with a lubricant of silicone fluid, a drawing furnace will be constructed for operation at temperatures up to 700° F. the conveyor moving through the furnace instead of outside.

Laboratory tests and limited experience in industrial plants has indicated that the lubricant, Dow-Corning 710G silicone fluid, is satisfactory for conveyors under light loads at temperatures ranging from zero to 700° F. Bearings are first lubricated with 710G, and relubricated as required with Dow-Corning 710, which is the same as 710G but without graphite.

In service, trolleys lubricated with 710G have shown no tendency to harden or "lacquer up." The lubricant remains liquid and free from stickiness so that the graphite contained in solution functions satisfactorily.

The usual operating practice has been to inject about ½ fl. oz. teaspoon of 710G into each trolley. Bearings with retainers are used, so that the fluid will not contaminate the Bonderite or cleaning fluid.

Operating experience to date indicates that this type of conveyor lubrication is satisfactory up to 700° F. under loads as high as 400 lb. Previous experience with mineral oils under these conditions had resulted in excessive carbonising and sludge formation, and the use of additional graphite failed to satisfy the operating requirements.

Iron Age, 166 16.83.

SWISS AGENT FOR FRITS?

A SWISS firm is interested in representing a manufacture of frits and glazes (enamel), used in ceramics, porcelain and allied industries.

Further information will be sent to those interested. (*Ed.*)

BRITISH CERAMIC SOCIETY

Paper and Its Relation to Pottery Decoration

THE following is a precis of a Paper presented to the British Ceramic Society on 13th November, by Mr. N. Edge:

It was stated that the greater proportion of ware is decorated by one of the numerous printing processes available and each of these requires a special paper to suit the particular process. The production of these papers and the maintenance of the required standards of quality are far from easy and other difficulties are caused by the fact that most of the papermakers' raw materials are imported.

A Brief History

The history of the art of papermaking was briefly traced from its invention in China by T'Sai Lun in A.D. 105, to the invention of the modern papermaking machine by Nicholas Louis Robert in 1798, and its development in this country by the brothers Henry and Sealey Fourdinier by whose name the machine is now known. Henry Fourdinier moved to North Staffordshire after his financial collapse and erected one of his paper machines at a Flour Mill in Hanley and made pottery and other fine tissues. The mill at Ivy House (Mill No. 630) was carried on from 1854 to 1890 by Thomas Brittain and Son, and in 1890, the mill was amalgamated with that of Cheddleton and a limited liability company formed under the title of Brittains Limited. In 1906, the Hanley Mill was converted into a paper coating mill and all papermaking processes concentrated at Cheddleton. There has thus been a long and intimate association with the local ceramic industry and this has produced a number of special papers which have enabled substantial advances to be made in the art of ceramic decoration.

A brief description of the papermaking processes was given, illustrated by lantern slides. The importance of the beating operation and the correct treatment by the beaterman of the maceration of the fibres was referred to and also the various after-treatments of the paper such as calendering, glazing and coating to convert it to the special papers of interest to the pottery industry.

Duplex Paper

The introduction of Duplex paper in 1895 enabled potters to enrich the decoration of china and earthenware by multi-colour designs such as could be produced by the lithographic process. The introduction of this double paper gained an enormous advantage and now provides the basis for the great bulk of pottery decoration over the whole world.

Though new methods of pottery decoration might be developed by applied research to meet new requirements, it was felt that we were a very long way from seeing the end of our long established processes. Improvements could be expected in the latter by the use of the photolitho process, the "step and repeat" method of building up litho plates combined with the rotary offset press all of which should make for cheaper lithos and permit more scope to the designer.

The limitations of the litho process was one of the causes of the introduction of silk screen printed ceramic transfers, and this process required another special type of paper. This was an absorbent paper coated with gum and a thin film of cellulose acetate. This type of paper permits the use of "slide-off" technique and eliminates the need of sizing the ware. This type of paper has however, not proved ideally suitable for the litho process owing to the fact that the paper tends to be more curly than Duplex and because the collodion film is difficult to clean after dusting. The possibilities of a paper coated with a thermoplastic were referred to.

The paper ended with a reference to a new development concerning a new ceramic transfer printing method in which a special foil coated with ceramic colour was used. A heated die cut to the design required stamps the colour from the foil on to a suitable transfer paper. A very simple machine suffices for the process. Due to the high density of colour that can be printed, the effects obtained are similar to those of hand-painting and silk-screen, the print appearing to stand up from the ware.

SCREEN PRINTED TRANSFERS

by

E. R. BOX

Johnson, Matthey & Co. Ltd.

IN a lecture given recently to the British Ceramic Society, Mr. E. R. Box first outlined the process of silk screen printing, and its applications. He referred to early experience with enamelled signs and to his company's efforts, directed first towards the glass industry, in the years following 1935.

Referring to the chief features of screen printing transfers, he said they differ in many respects from the litho transfers. A special type of paper is used, consisting of a porous backing paper, coated first with a water-soluble gum, and then with a transparent tough film of collodion. The design enamels are printed direct on to this film, which acts as a carrier for transferring the design to the ware. Application of this film to the ware is by "waterslide" method.

Method of Application

First, the transfer is soaked in water, usually in a shallow tray containing a pad of linen or similar non-fluffy material, which is kept wet with clean water—preferably running water. The cut transfers are placed face upwards on the wet pad. After a short time, the water penetrates the backing, dissolves the gum and allows the film to slide from the backing. This film is then slid, face upwards still, on to the ware. It should be noted that the film is very tough and can be handled freely without damage. When the wet film is on the ware, it may be moved about easily until the desired posi-

tion is found. This, however, needs to be done reasonably quickly before the water begins to dry. The design is easily visible on the ware. However, all air and water must be removed from behind the film since if left behind the film will blister after firing. For most articles, particularly those which are reasonably flat, a rubber squeegee is the best tool and the film is stroked with this, working from the centre of the motif towards the edge. In some cases, especially for large flat pieces, a rubber roller may be used. Where the ware is not flat enough for a squeegee or roller, a pad of blotting paper may be used. Whichever type of squeegee is used, it is important to work from the centre towards the edge of the film. Unskilled labour can be trained to apply these transfers very quickly.

Awkward Shapes

In the case of pieces having a pronounced spherical curvature, especially concave, it is more difficult to secure good contact and it is desirable to make radial cuts in the films, in any suitable spaces between the enamel deposit, to facilitate the process of securing good contact. In some cases, where the spherical curvature is very pronounced, it may be impracticable to apply the transfers at all but such shapes are, however, very troublesome to any type of transfer decoration. A lot can be done from the design stage onwards, to help with this problem.

Firing

Almost immediately after application, the ware is ready to fire. No maturing is needed. No special or exceptional facilities are required for firing, as both the gum (a little of which is retained beneath the film) and the film itself have been carefully formulated to burn away easily. May I, however, emphasise the importance of good ventilation in the enamelling kiln, not only when firing these transfers, but any kind of over-glaze decoration, including liquid gold, lithos and prints. The organic constituents need oxygen for combustion and this can only come from good ventilation.

The chief characteristics of screen printed transfers is the unique relief effect produced by the heavy deposit of enamel, exceeding that by any other mechanical method of decoration.

The method is simple in application.

Permanence

Since pottery is a relatively permanent acquisition the decoration should warrant reasonable description as permanent. Not all enamels employed for decoration warrant this description. Kiln temperatures are often high enough to cause such enamels to go into the glaze and thereby attain some degree of permanence but this is practicable only if the enamel deposit is thin. Screen printed enamels are applied too thick to fire completely into the glaze, so that the enamels themselves must have a high degree of permanence. Thus all enamels used in screen printed transfers must be highly durable and laboratory tests have been devised to determine the required physical and chemical characteristics.

Overprinting

It should be noted that with screen printing, no direct shading of the colours is possible, for the enamel deposit which prints through the screen is uniform in thickness and appears in the same shade or depth throughout. Thus designs which depend on shading or half tone effects are accordingly not suitable for screen printing. However by overprinting two or three colours the technique gives the effect of shading very successfully. Complicated floral sprays, can be reproduced with remarkable precision and effect.

In theory, there is no limit to the number of colours used but in practice, seven or eight is usually the maximum, and more often, four or five are quite sufficient. In fact some of the most effective screen printing has been produced in no more than three colours. There is a distinct limit to the fineness of detail which can be printed and very fine lines and minute detail must be avoided.

Wholly continuous border patterns, in particular, are unsuitable for reproduction by screen printed transfers. The enamel deposit is so thick that an invisible join is not possible. Here again, however, the skill of the designer can largely overcome this limitation and the effect of a continuous border is easily contrived by arranging a number of small breaks in the pattern. Some of these breaks can be utilised for joining sections of the border.

One of the most interesting developments is the use of gold either alone, or more important, together with enamels. This allows the printing of a rich deposit of a burnish type gold, and when this is used in conjunction with a suitable enamel pattern, the final effect is very attractive, and represents a considerable advance in transfer decoration. Exactly the same application technique is employed, the gold deposit offering no difficulty and requiring no additional precautions.

The use of transfers of this type offers a means of producing a very high-class decoration by a simple transfer process.

In conclusion, Mr. Box said that silk screen transfers should be judged solely on their own merits, as an additional tool in the hands of the pottery industry for it is decoration which helps to sell pottery.

DRUM-COAT

THIS is a new non-mechanical method of printing letters, numerals, trade-marks, etc., on to all types of cylindrical containers. The loss of time and messy wastage of materials, in stencilling such markings is completely eliminated.

The application of the Drum-coat process is shown in the illustration. A film of rub-proof and weather-resistant ink is rolled-up on a slab, transferred by hand rolling on to the composition type of formes, over which the drum is rolled without manual effort.

Further information can be obtained from Parsons, Fletcher and Co. Ltd., 72-78 Fleet Street, London, E.C.4.

The application of the Drum-coat process

POTTERY AND GLASS IN SCOTLAND

PLANS mooted a year ago for the development of electrically-fired pottery production in the Scottish Highlands have been carried forward steadily and successfully. The North of Scotland Hydro Electric Board listed pottery production as a source of potential usage and has been actively behind the scheme.

Small electric kilns are proposed and some have actually gone into use in the studios of potters. An even more important move is the interest shown by schools. In some Highland schools pottery production is now a recognised handicraft—designed to encourage later adoption of the work as a handcraft. Using local clays, a number of schools are now producing quite creditable ware. The lack of firing equipment has been a handicap to date but in several of these schools kilns are now being installed to facilitate complete production. Ellon Academy has just installed an electric kiln and classes are being arranged for schoolmasters and art masters in the area to expand this work.

Glass Engraving

The very substantial progress made in Scotland on the training of glass engravers—a development inspired by Helen Monro and the Edinburgh College of Art—was demonstrated last month in Edinburgh. Representative work from former pupils of the College was shown at an exhibition in the Huntley House Museum. Miss Monro collected the pieces shown and was responsible for the layout of the exhibition.

Included among the work were examples of Miss Monro's own work, sculptured figure work from Yvonne Simpson and Shiela Love, diamond point engraving by Alexandra Herries, beer mugs by Alison Geissler, goblets by Harold Gordon and flat plaques engraved by Dorothy Brown. These examples of Edinburgh-inspired work emphasise the scope and range of artists trained in the school. Several of those showing have established themselves as artist-engravers and have created a market for their work—particularly abroad.

In the commercial glassworks, the shortage of skilled engravers is a current headache, the tendency being for really skilled men, who may not be artists but rather sound technicians, to establish themselves as contractors.

Scottish Craftsmen

A new centre opened in November in Glasgow under the name Scottish Craftsman promises to provide a clearing house for ceramics, produced by Scottish artist potters, as well as for glass, engraved glass, metal and woodwork. Idea behind this venture, which has been located in attractive premises in Bath Street, is that a suitable atmosphere is necessary for the display and sale of craft work. The sponsors are showing discrimination in accepting work and are insisting on a high standard. Magnificent engraved glass from the Edinburgh and Leith Flint Glass is shown, for instance, as well as pottery work from a number of potters now working throughout Scotland.

A VISCOMETER FOR CLAY SLIPS

A KNOWLEDGE of the viscosity of clay slips is important. Viscosity is measured in poises: water at room temperature has a viscosity of one hundredth of a poise (a centipoise).

One of the characteristics determining the elastic behaviour of a solid is its "modulus of rigidity" G defined as the ratio of the shear stress s to the angle of shear θ measured in radiants. If s is in dynes/cm.^{2} and D in sec^{-1}, then η is given in poises.

η is a characteristic of a liquid in much the same way as G is of a solid.

A New Viscometer

The method chosen for a new viscometer is basically that due to E. C. Bingham and H. Murray (*Proc. Am. Soc. Test. Mats.* 23 *p.* 655, 1923) and the novelty consists in the method of producing a known constant air pressure. This constant air pressure forces the liquid under test into a horizontal glass capillary tube marked in such a way that the viscosity is numerically equal to a simple multiple of the time taken for the end of the liquid column to pass from one mark to another. Unlike many viscometers one does not need to know the density of the liquid nor is it necessary for the sample to

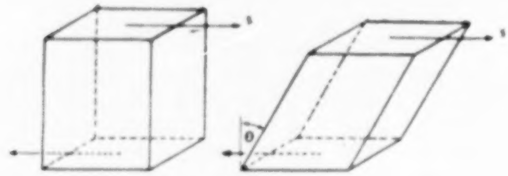


Fig. 1. Shearing of a solid block showing relationship of shear stress to angle of shear

$$\text{THE MODULUS OF RIGIDITY} = \frac{\text{SHEAR STRESS}}{\text{ANGLE OF SHEAR}}$$

$$\text{OR IN SYMBOLS } G = \frac{s}{\theta}$$

If a block of liquid is sheared as in Fig. 1 the angle of shear steadily grows larger and larger because a liquid cannot sustain a steady load as does a solid. The liquid does not give way instantaneously, and in a simple (or "Newtonian") liquid the rate D at which the angle of shear grows is equal to the shearing stress s divided by the viscosity η, or in symbols:

$$\eta = s/D \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

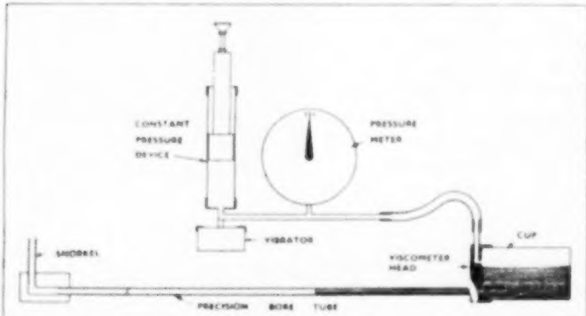


Fig. 2. The essential features of the viscometer are shown here, in diagrammatic form

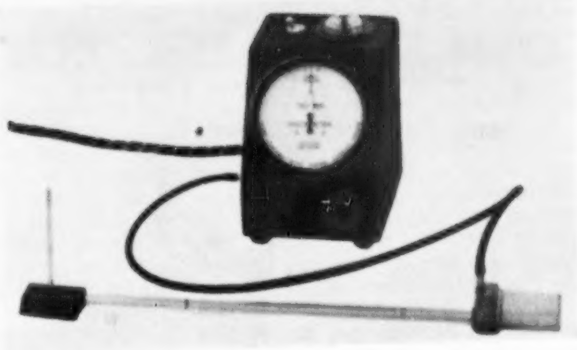


Fig. 3. The new type industrial viscometer

have some specified volume. The viscometer is easily cleaned, works equally well with opaque or transparent liquids and there are no troubles due to evaporation. Its range is about 50 centipoises to 2,000 poises or more.

Constant Air Pressure

The constant air pressure is produced by what is essentially a dead weight gauge operating under conditions of law friction and giving a pressure of the order of 60 cm. of water, much below the lower limit at which a conventional dead weight gauge can operate satisfactorily. The device consists of a polished plunger sliding freely in a cylinder into which it has been previously ground so that in the absence of lubricant the plunger will slowly descend under gravity when the end of the cylinder is closed. A little lubricant will then seal the plunger which is weighted to give the required pressure. In order to give consistent results the piston is vibrated by an electro-magnet connected to alternating current supply mains. The effect of this rapid vibration, which can be of quite a small amplitude, is remarkable and the pressure is maintained constant to $\pm$ 0·2 per cent. Fig. 2 gives details of the essential features of the instrument, and Fig. 3 shows the general appearance.

The constant pressure is applied by a rubber tube to the metal cap of the viscometer proper. A precision bore glass tube is fitted into this metal cap which is pushed over the tapered end of a small metal or polystyrene cylindrical vessel containing the liquid. A clean, dry capillary tube must be used for each determination. When assembling the viscometer it is good practice to smear a little of the liquid under investigation round the neck of the polystyrene container to ensure an airtight fit when it is pushed into the metal cap. A "snorkel" is fitted to the end of the capillary to allow displaced air to escape and prevent water entering the tube. The viscometer is laid horizontally in a water bath, but no special care need be taken to secure horizontal alignment.

As soon as temperature equilibrium has been attained the plunger can be released by giving it a slight rotation so that air pressure is applied to the liquid in the container.

In routine investigations time can be saved by standing the samples, each in its container with a lid on it, in a water bath so that temperature equilibrium is attained before assembly of the viscometer.

Operation

In the pressure unit the piston is producing a pressure which is indicated by the needle of the meter. The liquid is being forced from the polystyrene cup along the precision bore tube and is nearing the end of its run towards the last mark on the tube. When it reaches this mark the operator will press the stop watch and determine the time taken. Most capillary tubes are calibrated with two marks; this gives a double check and also enables a given number of tubes to cover a wide viscosity range.

The piston of the pressure unit has

been locked in the upper position and the meter is not therefore registering pressure. If further readings are required it is only necessary to insert a clean tube using the same sample or, if required, another sample.

As the capillary tubes are straight they are easily cleaned by flushing with water or other liquids. Very viscous materials (which are used with tubes of big bore) can be forced out rapidly with a plunger made by threading a tiny piece of rag through the eye of a mattress needle.

E. M. Oliver (*J. Amer. Ceram. Soc.* **31.** 128-132 (1948)) has shown that measurements of apparent viscosity give information closely parallel to that of "pick up" and "slump" tests of the consistency of wet milled porcelain enamel slips. Tests of apparent viscosity can be made with a suitably designed viscometer with accuracy and by untrained personnel and have the advantage of measuring in reproducible terms and well defined physical conditions.

Because the "Techne" viscometer is an absolute instrument using precision bore tube the user can be sure that the instrument will be used at the same range of shear stress for any given diameter of tube. This is a great significance in testing the apparent viscosity of non-Newtonian liquids such as enamel slips. If desired it is possible with the instrument to plot the curve of velocity gradient against shear stress for non-Newtonian liquids and thus to make a fundamental anlaysis of their rheological properties. For routine control tests in a works however it is sufficient to find the time taken in seconds for the liquid column to pass from one mark to another and to call this as "the apparent viscosity." Provided the tests are always done with a tube of the same diameter they will give true corporative values for the consistency of the enamel slips.

The instrument has been in daily use for eighteen months in the control laboratory at Aero Research Ltd., and is marketed by Techne (Cambridge) Ltd., Duxford, Cambridge.

MODERN DEVELOPMENTS IN METAL FINISHING

**Arrow Press Ltd., 29 Grove Road, Leighton Buzzard, Beds.
5/- Post Paid**

THIS is an edited version of eight lectures given recently at the Northampton Polytechnic, London, under the auspices of the Head of the Applied Chemistry Department, Dr. J. E. Garside.

The contents include: Developments in Electrodeposition Processes and in Plant for Electrodeposition, by E. A. Ollard, F.R.I.C., F.I.M., of the British Non-Ferrous Metals Research Association; Phosphate Treatments for Iron and Steel, by H. A. Holden, M.Sc., A.R.C.S., D.I.C., A.I.M., of the Pyrene Co. Ltd.; The Protection and Decoration of Aluminium, by V. F. Henley, B.Sc., F.R.I.C., of W. Canning and Co. Ltd.; and Methods for the Protection of Magnesium Alloys, by W. F. Higgin, Ph.D., of Magnesium Elektron Ltd.

Three lectures dealing with the history and general principals, the composition and application methods and their industrial applications of vitreous enamel are included by W. E. Benton, M.Sc., of S. Flavel and Co. Ltd., S. Hallsworth of Metal Porcelains Ltd., and H. Laithwaite M.Sc.Tech., A.R.I.C., of Radiation Ltd.

MODEL SAFETY RULES
Part I
Supplement No. I

THIS supplement issued by The Association of British Chemical Manufacturers, and relating to the chemical industry contains the changes made necessary by the Factories Act, 1948, together with a few minor changes and additions as the result of experience in use.

The amendments are printed on separate gummed slips to allow of insertion in the blank pages provided for that purpose in the existing rules. Copies of the supplement are being sent gratis to all known purchasers of the original edition of Part I. The amendments will be incorporated in future editions.

Copies of the Third edition of Part I, including a copy of this first supplement, are still available from the Association office at 166 Piccadilly, London, W.1, at the nominal price of 7s. 6d. post free cash with order.

VITREOUS ENAMELLING

A Continuous Vertical Electric Oven Installation

by

A. J. GIBBS SMITH

THE working end of an interesting electric furnace for the enamelling and similar trades is illustrated by the photograph reproduced (Fig. 1), where it is shown working upon a charge of plates for a cooking oven, the charge being ready for lifting upwards into the furnace. The construction of this latter can be seen from the sectional view (Fig. 2), which shows that in plan it is of rectangular cross-sectional area, the vertical shaft being divided into two parts, the upper of which forms the heating chamber proper, while the lower portion serves as a preheater for the incoming charge or a cooling-down zone for the outgoing load.

The particular furnace illustrated was installed about two years ago in a well-known German enamelling plant in a building consisting of several stories, the lowest of which is the working floor. The oven is served by three sets of electrically-operated rising-and-falling gear, the operation of which is timed so that while one charge of work is in the heating zone, another is either being preheated or is cooling off in the lower portion of the oven, and another load removed and a fresh charge substituted immediately beneath.

In Fig. 1 a fresh charge of work has just been hooked up and the door of the preheating chamber opened ready for the work to be raised. The lower end of the furnace is about 6 ft. 6 in. above floor level, and is provided with a door in two parts. Provision is made for loading and unloading by hand, and, when necessary, for the incoming charge to be carried immediately into the heating zone without any preheating. Insulation is such that when the furnace is at work the hand can be placed on any portion of the outer casing. Heating is by spiral elements, readily replaceable, arranged in three tiers, and the temperature required for the process which is being undertaken can be maintained automatically.

Of the advantages offered by this design, some are the natural result

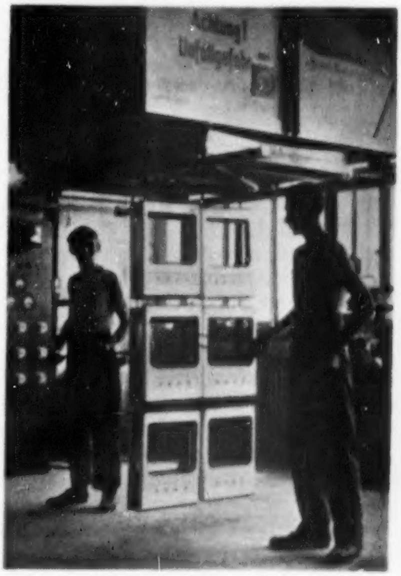


Fig. 1. Work ready for lifting upwards into the furnace

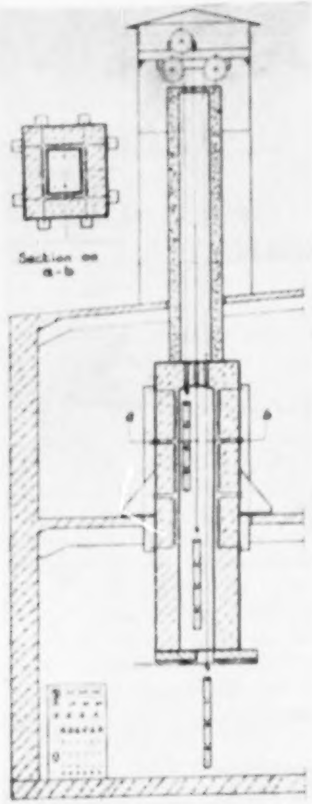


Fig. 2. Sectional view showing construction of the furnace

of the employment of electric heating, such as the economies effected by eliminating the cartage and storage of fuel and the removal of ashes, the automatic regulation of temperature, automatic starting after a week-end shut-down, elimination of lost time and output which is inevitable for periodically repairing the muffle of a solid-fuel furnace. Other advantages result from the particular design employed; for instance, burnt cinders and debris drop straight through the furnace instead of accumulating on the hearth or floor of the muffle, so that periodical cleaning for this purpose is not necessary, a considerable advantage when changing over to white ware. Amongst other advantages of the type are: output is increased both on account of the continuous method of operation which ensures that the furnace is never empty, by the preheating of the charge, and by the reduced weight of the carrier gear compared with the usual system of perret supports employed in a horizontal furnace, which may on occasion be more than the net weight of the work.

For instance, the rising-and-falling gear and hangers in the case of the cooker plates already referred to is only one-sixth of the weight of the charge, and in the case of double cooker plates only one-seventh; in fact, in this particular installation the weight of the carrying gear is stated to be on an average about a twelfth of the weight of the supports which were formerly used for the same class of work when fired in a horizontal furnace. Flat pieces such as the plates shown in the first photograph and in the sectional view are hung in pairs back to back. In the case of larger work, the three sets of rising-and-falling gear are

Fig. 3. With thin, bulky holloware consumption is 290 kwh. per ton

replaced by two, or even reduced to a single set when the size of the work begins to approach the measurements of the cross-sectional area available for its accommodation.

The rating of a furnace with internal dimensions 1 ft. 8 in. by 4 ft. 0 in. by 6 ft. 7 in., which is the capacity of the oven illustrated, is some 100 kw., but provision is made for specially long work by switching on lower reserve heating elements, thus increasing the loading to 140 kw. and the height of the heating zone to 8 ft. 0 in.

Consumption and output figures obtained on such a furnace in the case of double cooker plates $\frac{1}{16}$ in. thick are stated to be for the ground coat 225 kwh. per ton and 8 cwt. per hour. For annealing these plates at 800° C. the consumption is reduced to 175 kwh. per ton and the output is 10 cwt. per hour. On thin and bulky holloware such as 2 gal. buckets the consumption is 290 kwh. per ton with an output of $5\frac{1}{2}$ cwt. per hour. On the ground coat of front plates for electric cookers 1 mm. thick consumption is increased to 235 kwh. per ton with an output of 7 cwt. per hour.

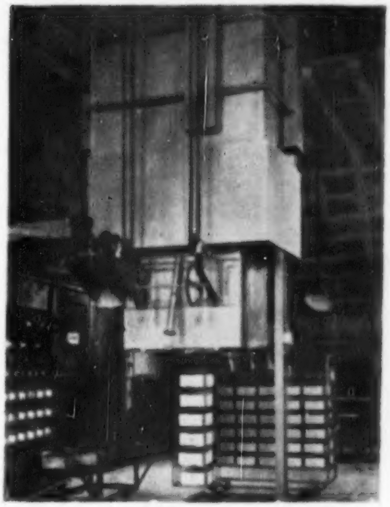


Fig. 4. Working end of smaller furnace of similar type

The photograph Fig. 4 shows the working end of a smaller enamelling furnace of the same type.

A REFLECTANCE AND GLOSS METER

THIS instrument, marketed by Albright (Engineers) Ltd., 125 Red Lion Road, Tolworth, Surrey, is a multi-purpose unit for taking measurements of reflected light from a surface, as a means of grading surface quality. Direct measurements can be taken of diffused reflection (reflectance), specular reflection (gloss) and colour, as represented by readings through three coloured filters in turn. In addition to direct recordings the instrument can also be used as a comparator, in each of the above three types of measurement. No new principles are embodied, but the instrument has been developed with a view to improving upon existing methods of measurement, with particular emphasis upon accuracy, ease of reading and portability.

New Features

The incorporation of several special features, such as suppressed zero controls for galvanometer scale expansion, enables the instrument to be used both in laboratories and production departments. Direct measurements with a high degree of accuracy are obtained. The instrument can be set to give wide swings of the galvanometer needle when there is very little difference between the values of the surfaces being measured.

A safety switch, automatically operated by the lid of the instrument box, ensures the damping of the galvanometer needle when the instrument is being carried about.

Albright Reflection Meter

The complete unit consists of three main components. The instrument box is the recording unit and it contains the voltage stabilising set; the lead and plug for connection to the power supply; the instrument panel; the safety switch; a compartment for stowing the search units, a wallet containing dark and light standard plaques, a black glass plaque tri-green, tri-blue and tri-amber filters.

The Albright Reflectance and Gloss Meter

The instrument panel carries a galvanometer of the sensitive taut wire type with mirror scale and two scale divisions. The lower scale is graduated 0 to 100 in black characters and the upper from 50 to 100 in red characters for use with suppressed zero controls. A zero adjustment screw is provided on the top of the galvanometer.

There are four control knobs in line along the front of the panel as follows:—

Left-hand: Green spot—coarse control for suppressed zero on a dark standard.

Right-hand: Green spot—fine control for suppressed zero on a dark standard.

Left-hand: Red spot—coarse control for true zero and also supressed zero on light standard.

Right-hand: Red spot—fine control for true zero and also suppressed zero on light standard.

In addition there is a mains switch, a safety switch and a search unit connection.

Reflectance Search Unit

The reflectance search unit is used for determining the reflectance and colour specification of any surface finish. The light beam is projected normal to the surface, and the intensity of the reflected beam at 45° in all meridian planes is measured by means of a selenium cell. A similar cell, energised directly from the lamp is brought into circuit for suppressed zero measurements.

A slot is provided to receive the green tristimulus filter for reflectance measurements and the green, blue and amber filters in turn, for colour specification work. The search unit is supplied complete with wandering lead and plug for connection to the socket on the panel of the instrument box.

The gloss search unit is used for determining the gloss (specular or regular reflection) of a surface finish, which is a surface effect only, as distinct from reflectance (diffuse reflection). Several types of gloss have been defined, but the one measured by this instrument is defined by "intensity of the specularly reflected light beam." This should not be confused with that defined by "sharpness of the reflected image."

The light beam is projected on to the surface at an angle of incidence of 45° and the reflected beam at an angle of reflection of 45° is directed on to a selenium cell. A similar cell, energised directly from the lamp is brought into circuit for suppressed zero measurements.

Brightness Factor

The brightness factor is the property of a surface which determines whether it appears light or dark irrespective of its colour. The brightness of a coloured surface is expressed relative to the brightness of a surface of magnesium oxide under the same conditions of illumination.

The colour quality is the property of the surface which determines its colour, irrespective of whether it is light or dark. It is denoted by three numerical values—the tristimulus values, which are determined by adopting the procedure described under "D—White and Near-White Surfaces," using the tri-green, tri-blue and tri-amber filters in turn. The light standard plaque is used for setting, instead of the dark, and in items 3 and 4 the galvanometer needle is set each time to coincide with the respective values marked on the back of the light standard plaque.

The tristimulus values are then calculated as follows:

$X = 1{\cdot}26A$ where A = reading through tri-amber filter.

$Y = G$, where G = reading through tri-green filter.

$Z = 2{\cdot}70B$ where B = reading through tri-blue filter.

If the tristimulus values, X, Y, Z, of one surface are identical with those of another surface, then the two surfaces are of the same colour.

When the purpose of the measurement is to determine whether or not two surfaces are a colour match, it is sometimes useful to magnify the deviations by employing the suppressed zero controls.

The instrument can also be used for grading a large number of surfaces of approximately the same colour.

Whilst colour measurements with this instrument are valuable in standardising colours and registering deviations, it cannot, of course, furnish direct information on the amount of any pigment to be added or left out in order to obtain a particular hue.

Correction Factor

In order to compensate for the effects of diffuse reflection, the gloss readings obtained must be corrected to give the true gloss.

True gloss is obtained by deducting from the scale reading, one-half of the diffuse reflection value of the surface, as measured with the reflectance search head.

The type of gloss measured is defined by "the brilliance or intensity of regularly reflected light." This must not be confused with the type of gloss defined by "distinctness of the reflected image," when judging gloss by visual observation.

The various applications of the instrument already mentioned refer to true-zero measurements and utilise the lower, black scale of the galvano-head, the lower scale then covers the whole range of reflectance from perfect black (zero per cent.) to perfect white (magnesium oxide 100 per cent.).

Higher Scale Expansion

The scale of the galvanometer can be made to represent a narrower range of reflectance values, whereby a wider spread of readings for specimens of approximately equal reflectance can be obtained. Examples of this use are in determining values between known standards and measuring the uniformity of large surfaces.

The gloss search head can be substituted for the reflectance search head in all the measurements with suppressed zero, just described. Thus the galvanometer scale can be set to provide:

(a) Values between two known standards.

(b) Grading of surfaces between two limits.

(c) Uniformity of large surfaces.

PAINTING ON MOIST SURFACES

THOS. SWAN AND CO. LTD., Love Lane, Rugeley, Staffs, consider they have succeeded in developing this idea by producing a "wetting agent" for addition to oil and bituminous paints. The product "Aquapaint" repels water, and a 1 per cent. addition to the paint is claimed to promote its adhesion to wet surfaces; it also increases adhesion to dry surfaces.

Thus its use would enable painters to work in wet or humid weather or to paint damp interior walls.

"Aquapaint" is supplied as a solution in white spirit. An average addition is 1 oz. "Aquapaint" to 1 gal. of paint. In this proportion the drying properties and the colour of the paint are considered to be unaffected.

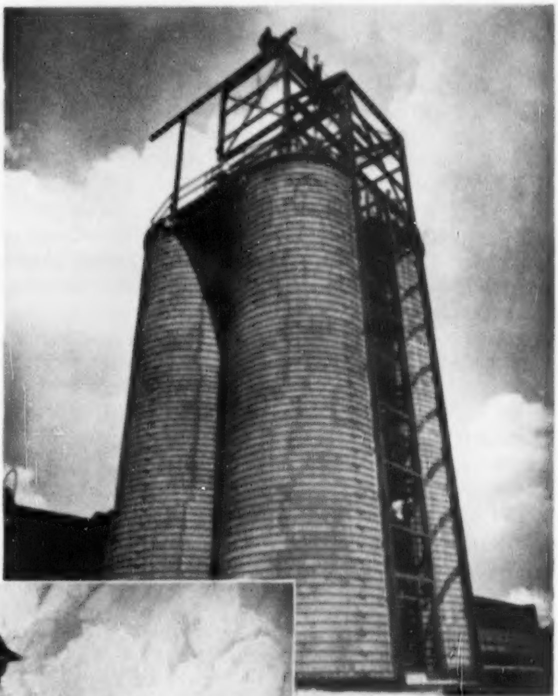
It would also facilitate the painting of non-porous surfaces such as glass or galvanized steel. Mixed with white spirit in a 1 : 10 proportion it is used as a primer.

It is useful in painting the under-water hulls of ships in dry dock or those parts of gasholders in the waterseal; for wet steelwork; scaffolding in mines; new wood or plaster which tends to "sweat"; priming concrete reservoirs or pipes which are to be waterproofed with bitumen; and repainting felted or wooden roofs which tend to retain moisture despite their surface-dry appearance.

Elliott Bros. Sir Walter St. David Jenkins, who has been chairman of Elliot Brothers (London) Ltd., for many years, has decided to hand over this post to a younger man. Sir Walter has agreed to remain on the board of the Company, to whom his long and valuable experience will continue to be available. The directors announce that Captain R. E. F. de Trafford has accepted the chairmanship.

LARGE SCALE HANDLING OF CLAY MATERIALS

Structural steel workers are seen (right) preparing supports for a seven-ton vacuum tank on these 68 ft. high silos at the Derry Works of the American Westinghouse Co.



The tank will draw powdery flint, feldspar, and Kaolin, ingredients in the porcelain insulators manufactured at the plant, from railway trucks and store it in the silos. The picture (left) shows the old method of working this dusty and difficult material

New Coke Ovens at East Greenwich

Part Played by Refractories

ON Thursday, 7th December, 1950, a new coke oven plant was inaugurated by H.R.H. The Duke of Gloucester at the East Greenwich Works of the South Eastern Gas Board. These works, the largest of the South Eastern Gas Board, are situated on the Old Greenwich Marshes at Blackwall Point. The original site was acquired in 1881 and gas making commenced there on 30th July, 1887. The works now cover an area of 130 acres with an extensive river frontage and a large T shaped jetty where the Board's colliers are unloaded and chartered vessels loaded with coke for export to the Scandinavian countries.

In all installations such as this and in steel works, the heart of the heat generation and utilisation process—the refractory linings and brickwork—are hidden and do not get their fair share of the "glamour."

In recent years, the gas making capacity of "East Greenwich" has been 34 million c. ft. per day produced by the carbonisation of Durham coals in horizontal retorts, the carbonising plant consisting of twelve retort benches with a total of 1,800 retorts. The power system was based almost entirely on the use of steam and hydraulic power.

Towards the end of the 1939-45 war the management of the former South Metropolitan Gas Company reviewed the future pattern of gas manufacture with the intention of systematically replacing obsolete plant by modern systems. The scale of manufacturing operations at this works offered considerable scope for this and it was decided to install coke ovens as the most suitable form of base load plant and to adopt water gas generation to obtain the flexibility of output necessary to meet the daily and seasonal fluctuations in the public demand for gas.

It was therefore decided to erect, as a first stage of development, two batteries of coke ovens which would constitute the base-load element of gas production and four units of carburetted water gas plant, with a capacity of 12 million c. ft. per day, to carry the flexible load.

This major engineering project, with its high degree of mechanisation, naturally needed the support of auxiliary services far in excess of those already available, it being necessary to adopt the use of electric power, and to provide substantial supplies of water for cooling purposes and for the extension of steam raising. New coal and coke handling systems were also required. These problems were solved by the provision of the following:

(a) A power house covering the initial demand for 2,000 k.w.h. with provision for future developments.

(b) Twelve waste heat boilers to supply steam for the power house and other plant.

(c) A river water pumping system supplying 600,000 gal. an hr., providing cooling water for con-

densers and for gas cooling.

(d) An artesian well supplying 20,000 gallons of water an hr. for steam raising.

(e) New coal handling plant.

(f) New coke handling plant.

(g) A producer gas plant for generating cold clean gas for heating the coke ovens.

(h) A wet purification plant for the cooling and cleaning of coal gas produced by the coke ovens.

An increase in the manufacturing capacity of the station to 70 million c. ft. per day was a possibility borne in mind when the siting and general layout of the plant and its ancillaries was determined.

Foundations

The heavy structures associated with these developments have been carried out in reinforced concrete and the ground strata and soil conditions were closely examined in order to determine the most suitable type of piled foundations to carry the designed loads. The ground is normal for this part of the Thames Estuary, and down to a depth of 20 ft. consists of made ground and recent alluvial clay and peat, underlaid by about 25 ft. of dense flood plain gravel, followed by stiff blue clay. Cast-in-situ piles have been adopted, founded at a depth approximately halfway through the gravel. The ground water has a high sulphate content, a potential cause of disintegration of concrete made with Portland cement. To eliminate the possibility of attack, sulphate-resisting aluminous cement has been used for all concrete placed below ground level.

Coke Ovens

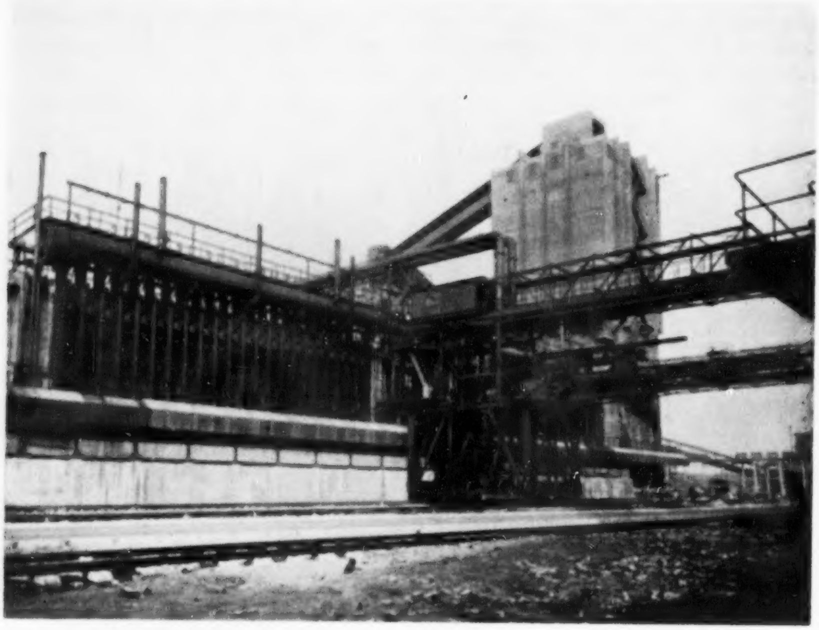
The first installation of coke ovens, two batteries each of twenty-two oven, were erected by Simon Carves and designed for a total throughput of 1,000 tons of coal per day. The layout of the plant provides for a duplication of this installation on the north side of the service bunker.

The ovens are built on a reinforced concrete decking, supported by columns carried on a reinforced concrete raft. The sub-structure so formed accommodates the fuel-gas distributing mains and the reversal equipment. The transverse beams of the decking are extended at either side to provide support for the buckstays on which the gas collecting mains, liquor and steam pipes are carried. The reinforced concrete

A general view of the new coke oven plant

retaining buttresses built at the ends of each battery are designed as beams, cantilevered from, and monolithic with, the foundations.

The Service Bunker, which holds 3,000 tons of coal and will ultimately serve 88 ovens, is constructed of reinforced concrete. The dead weight of the empty structure on the foundations is approximately 6,100 tons and it is supported on two reinforced concrete beams 8 ft. in depth, each of which is founded on 186 piles.



The ram machine discharging coke from the ovens. In the background is the service bunker

The carbonising period of 15½ hrs. for a 14½ ton coal charge entails the charging and discharging of one oven every 21 min. and at the end of this time the doors at each end of the oven are removed by power extractors, and the coke pushed out by an elecrically-operated ram.

The gas leaves the ovens through ascension pipes and collecting mains on both sides of the batteries. The ascension pipes which are 15 in. in diameter within the refractory lining are connected at their tops to the collecting mains by special pipes fitted with isolating valves to seal off the ovens during charging operations. A spray of ammonia liquor is introduced at this point and the gas undergoes its initial stage of cooling. The total flushing liquor used on the two batteries is 80,000 gal. per hr. The collecting mains then enter a common 54 in. dia. main which carries both gas and flushing liquor to the wet purification plant.

The principal dimensions of the ovens are:

Length over Sole ...	44 ft. 7½ in.
Height of Chamber	12 ft. 6 in.
Width of Oven Chamber—	
Ram Side ...	1 ft. 3 in.
Coke Side ...	1 ft. 5¼ in.
Length of Charge ...	41 ft. 7½ in.
Height of Charge ...	11 ft. 4¼ in.
Volume of Charge	618 c. ft.

The ovens are of the Twin Flue Compound type normally heated by producer gas, but employ under-jet firing when using coal gas as fuel. By Twin Flue—or, as it is sometimes called, "hair-pin" flue—is meant an arrangement whereby the heating gases pass up one flue and down the next flue in the same oven wall, a very short portway connecting the tops of each pair of flues. In a "compound" oven, provision is made to burn "rich" gas, e.g. coal gas, or "lean" gas, e.g. producer gas at will.

A high silica refractory material has been used for the oven walls, sole work and the upper courses of the regenerators.

Due to high rate of carbonisation the quantity of fuel-gas to be burnt in a given time is relatively large and the flame volume considerable, accordingly the flues are of ample size with an average cross section of 490 mm. by 330 mm. The regenerators below the oven chambers are packed with filling blocks specially designed to (a) offer a very large surface for heat interchange, (b) present the minimum obstruction to the free flow of gases, (c) avoid any points on which dust could lodge with the attendant risk of choking the passages.

Producer Gas Plant

Normally, the ovens are heated by producer gas generated in an installation of six Marishcka Producers erected by Humphreys and Glasgow, five producers carrying the load with one held in reserve. The Marishcka Producer was selected because of the special design of its annular boiler, which can generate high pressure steam in liberal quantities at the standard pressure of 160 lb. per sq. in. adopted on the works' waste heat steam-raising plant. Each producer consists of two annular vessels, positioned co-axially one above the other, connected by a nest of 180 3 in. diameter tubes, 2 ft. in length and arranged in three concentric rings. The diameter of the centre shell is 8 ft. and the fuel bed is contained wholly within the lower vessel.

The supply of fuel is so regulated that the level of the top of the fuel is always maintained below the top of the lower section of the boiler. The hot producer gas rising from the fuel bed has to pass more or less radially through the spaces between the tubes into an exterior annular jacket, the plates of which are insulated with Fosalsil bricks. It will be noted that the inner surface of the jacket is also the outer shell of the boiler, giving an additional heating surface. The gas travels round within the annular jacket to the main outlet, whence it passes into the steam superheater. This superheater is rectangular in shape, and contains a four-fold nest of tubes. The total heating surface of the boiler is some 660 sq. ft. and that of the superheater 240 sq. ft. Since the upper vessel or steam annulus is only partially full of water, its inner shell plates have to be protected against overheating and a firebrick dome is constructed inside the inner shell, commencing near the bottom of the vessel.

Each producer is rated to gasify 25 tons of coke per day, graded 1-2 in., and to generate 5,400 therms of producer gas at a calorific value of 125 B.Th.U. per c. ft. or about 4¼ million c. ft. per day. During this same period, it provides some 70,000 lb. of steam at 160 lb. per sq. in. and 500° F. superheat.

Coal Handling Plant

Since coal handling is of interest particularly to the heavy clay industry a description of the East Greenwich plant is of interest.

With the exception of the hydraulic cranes and receiving hoppers on the jetty, the plant used in the new coal handling system was erected by Sovex. Coal is removed by belt conveyors from the two sets of receiving hoppers and transferred to

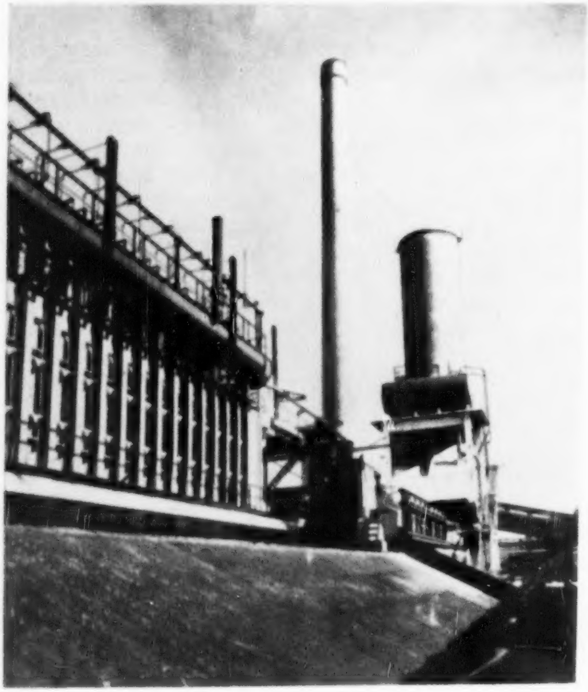
a single belt conveyor, feeding the screening and crushing plant. This plant, which is situated inshore over a transfer hopper of 90 tons capacity, effects a size reduction to 2 in. Coal required for distribution to other works on the Metropolitan Division is diverted at the jetty to a further conveyor and is discharged overside to barges through chutes.

From the 90 ton transfer hopper, coal can either be despatched by rail to the retort houses or coal field or be fed to a conveyor belt for delivery to the blending bunkers. Coal recovered from field stock can also be transferred to the belt feeding the blending bunkers. The capacity of this conveyor system is 400 tons per hr. and all coal handled is automatically weighed at various points in the system.

The coal blending plant consists of six vertical cylindrical bunkers, each 32 ft. in diameter and 74 ft. high, of 1,200 tons capacity and constructed in reinforced concrete as separate units. The base of each bunker is a ring beam carried on columns. The bottom of each bunker is in the shape of an inverted cone supported from this ring beam and is lined with Staffordshire blue quarry tiles with a cast iron discharge mouthpiece and feed tray.

The speed of the withdrawal belts can be regulated by variable gears enabling the discharge rate from each bunker to be adjusted at will from 40 to 150 tons per hour.

Coal flows from the vari-speed belts to a common collector belt, which delivers it to the secondary crushers, manufactured by the British Jeffrey Diamond Company, of the Flextooth type with a capacity of 150 tons of coal per hr., giving a size reduction from 2 in. to below ½ in. Present installation comprises two crushers with provision for a third.



A section of the plant showing the hot coke car entering the quenching station

The fluid flywheel transmission on all the electric motors on the coal and coke handling plants is of particular advantage in the case of a heavy machine like the Flextooth coal crusher as it permits the use of smaller driving motors than would otherwise be necessary, and enables squirrel cage motors to handle large starting torques.

Coal is elevated from the secondary crushers to the top of the coke oven service bunker by belt conveyors at the rate of 150 tons per hr. The capacity of these conveyors will be doubled by increasing the belt speed when the present installation of coke ovens is extended. At the top of the service bunker the coal passes to a revolving shuttle conveyor, which directs the flow of coal into any one of the three compartments of the bunker, securing good distribution and taking full advantage of the bunker capacity.

Carburetted Water Gas Plant

This plant serves the dual purpose of (a) providing diluent gas to reduce the calorific value of the straight coal gas produced in the coke ovens and horizontal retorts to the standard calorific value of 500 B.Th.U. per c. ft., and (b) to meet seasonal fluctuations in demand or heavy peak loads without incurring the high cost of maintaining a large proportion of standby carbonising plant.

When coal gas is diluted to the standard quality by adding diluent gas of a lower quality, the diluent gas contributes to the total output of the works. The higher the calorific value of the diluent gas, the smaller is its effectiveness as a diluent and the greater will be the quantity needed to reduce the calorific value of the mixture to the standard value. As the output of the works can thus be considerably augmented while still maintaining a constant maximum load on carbonising plant, peak loads can be met conveniently and economically.

In order to secure the wide range

of flexibility required, the plant has been designed to produce three types of gas:

(a) Producer gas at 130 B.Th.U. per c. ft.

(b) Blue water gas at 290 B.Th.U. per c. ft.

(c) Carburetted water gas at, say, 400 B.Th.U. per c. ft. or above.

Carburetted water gas will be produced during periods of heavy demand, but for periods of moderate or low demand the manufacture of blue water gas will be sufficient and more economical.

The plant will consist of four sets of Humphreys and Glasgow back-run carburetted water gas generators the site layout allowing for future extension to eight sets.

Each set will comprise a generator with automatic fuel feed and ash removal, carburettor, superheater, waste heat boiler and wash box. Operation will be fully automatic by the use of Humphreys and Glasgow's mechanical operators actuating Lockheed oil pressure mechanism.

The generators will be equipped with annular jacket boilers generating steam at a pressure of 50 lb. per sq. in. for use in the water gas process, or for saturating the blast when making producer gas.

Steam at 160 lb. per sq. in. to meet all power requirements of the plant will be produced in the waste heat boilers.

An unusual feature of this plant will be the provision of alternative means of cooling the gas produced. Condensers are essential for the cooling of carburetted water gas, but producer gas is best cooled by the direct contact, unfilled scrubber tower. Accordingly, coolers of both types will be provided, together with a suitable arrangement of valves to permit a ready change-over from one system to the other to suit the type of gas being manufactured.

The rated capacity of each of the sets when used on the three alternative phases of manufacture is:

Producer gas, 2·5 million c. ft. per day; Blue water gas, 3·2 million c. ft. per day; Carburetted water gas, 3·5 million c. ft. per day.

THE MANUFACTURE OF GLASS

Mr. P. M. Davidson Lectures to the South Wales Institute of Engineers

IN a lecture given before the South Wales Institute of Engineers, Cardiff, on the Manufacture of Glass, supported by films, Mr. P. M. Davidson, B.Sc. (Pilkington Bros.) opened by describing briefly the four fundamental methods of forming glass: blowing, drawing, rolling and pressing.

Blowing is the operation of gathering molten glass on a blowpipe and moulding it by blocking, blowing, spinning and swinging it to the desired shape. It is the original method of manufacturing sheet glass.

Drawing is the method now used for the manufacture of sheet glass. In principle the process can be likened to the effect produced when a knife, after being dipped in syrup, is held horizontally. The "sheet" of the syrup rapidly "waists." In glass manufacture this surface tension effect is resisted by edge rollers which nip and chill the edge of the

sheet. It thus becomes possible to draw a continuous flat sheet of even width.

Rolling is adopted in the manufacture of plate glass, rough cast, wired glass, and the Cathedral and figured rolled glasses. The process may be either continuous or intermittent. In the main it consists of passing the glass from the tank furnace to a pair of water-cooled steel casting rollers between which it is rolled into a continuous ribbon.

The fourth method, pressing, entails a quantity of molten glass being fed into a mould and pressed into shape by means of a plunger.

Polished Plate Glass

These introductory remarks were followed by a film illustrating clearly the manufacture of polished plate glass. It showed its evolution from the time when the raw materials were melted in open fireclay pots heated in furnaces; from there, after cooling, ground and polished on 30 ft. diameter steel tables to the present method whereby the raw materials are melted in huge tank furnaces from which the "metal" issues continuously through a pair of water-cooled steel rollers; passing from there directly in one unbroken ribbon through the lehr or annealing chamber to the grinding and polishing heads which grind and polish both sides of the glass simultaneously.

A short talk on the properties and characteristics of glass led up to a second film on "Armourplate and Armourlight." This illustrated the principles of the manufacture and properties of toughened glass and concluded with illustrations of a variety of applications.

In relation to the subject of the film it was explained that one of the most intriguing and spectacular of successes in the field of glass technology relates to the control of strains and stresses. There was here a reversal of the constant endeavour to obtain strain-free glass.

Towards the end of the 19th Century it was demonstrated in France that glass could be toughened by being plunged, while still hot, into an oil bath. Little use was made of this discovery at the time. The resulting phenomenon, in its most extreme form, resembles the familiar laboratory example of Prince Rupert's Drops where the state of the strain is so great that if the fine stem is broken off the whole flies off into a fine powder.

Properties of "Armourplate"

"Armourplate" is normal polished plate which, after cutting and working, is subjected to a physical heat treatment which endows it with greatly increased mechanical strength and, in addition, ability to resist severe thermal shock. The increase in mechanical strength of clear "Armourplate" over annealed polished plate of the same thickness is in the order of 4/5 times. So far as thermal resistance is concerned, provided that the heat is uniformly distributed, "Armourplate" glass will withstand temperatures up to 295° C. on one surface with the other surface exposed to ordinary atmospheric temperature. It has also been tested to 70° C. without its quality being affected. Each piece of "Armourplate" is indelibly branded with the name as a guarantee that it has been subjected to the special toughening process and has passed standard tests.

It was demonstrated at the lecture that "Armourplate" glass, if broken, disintegrates into innumerable small pieces not sharp enough to cause injury.

In conclusion a "live" demonstration was given with apparatus specially assembled to show the relative performance of polished plate and "Armourplate" under static loading, mechanical impact and thermal shock.

AEROFOIL FANS

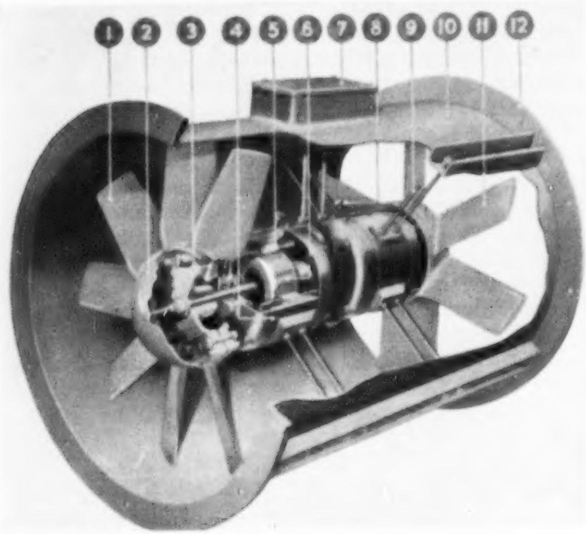
A New Development in Axial Flow Fans

WE have received a most interesting brochure from Woods of Colchester Ltd., an associate company of the General Electric Co. Ltd., dealing with Aerofoil fans.

This is claimed to be a new development in axial flow fans and a cross-section diagram of the fan is reproduced. All sizes of the adjustable impeller are geometrically similar and have identical characteristics so as to cover the entire range of volumes and pressures in smooth steps. This has been arrived at by maintaining the ratio of the hub without any proportionate noise increase.

Total efficiencies of the fans are in the neighbourhood of 70 per cent. over a wide range of volumes and pressures, with an efficiency at about 78 per cent. total and 67 per cent. static.

The brochure in question deals in detail with sound level ratings and performance characteristics. The multi rating selection tables are most comprehensive and show at a glance the most suitable fan available for any required duty within the capacity of the range.



1 Second-stage Impeller.
2 Domed hub fairing.
3 Adjustable pitch Impeller—this design is used on all Single Stage Fans above 12 in. diameter.
4 Totally enclosed motors built specifically for these fans.
5 A.C. stator laminations die-cast into aluminium carcases.
6 Die-cast squirrel cage rotor.
7 Weather-proof external terminal box.
8 Stauffer lubricators, easily accessible through inspection door.
9 Stainless steel fan supports.
10 Heavy gauge mild steel casings with channel iron reinforcements.
11 First stage impeller (fixed blade type).
12 Wide flanges drilled for fixing.

diameter to the impeller diameter as constant throughout the range.

A series of electric motors has been developed with frame diameters matching the impeller hub sizes and the motors are produced as integral parts of the fan.

There are nine sizes of single stage fans from 6 in. to 48 in. The adjustable impeller is fitted to sizes from 15 in. upwards whilst for the three smallest units 6 in., 8½ in. and 12 in. solid cast impellers are used.

An interesting point claimed about the Aerofoil is that the two-stage fans with contra-rotating impellers develop 2½ times the pressure of a single-stage fan

Dimensional details and prices are included in the brochure. Altogether a most useful shelf acquisition to users of industrial fans.

J. O. Twinbarrow.—Mr. J. O. Twinbarrow, manager of the publicity department of Babcock and Wilcox Ltd., is retiring from that position at the end of this year in order to take up an appointment as Secretary of the Boiler Availability Committee. Mr. Twinbarrow's successor at Babcock House, is Mr. G. M. C. Peacock.

AN ACID PUMP

THE Pulsometer-Doulton stoneware pump, of which leaflet O 912 refers, is designed to meet the limitations of stoneware as a material of construction. The hood carrying the pump forms a rigid support both for the pump itself and the two bearings, whilst the shaft is of large diameter ensuring freedom from vibration and distortion under working conditions. All interior parts are made in acid-proof stoneware, no other material coming into contact with the liquid being pumped. It is consequently able to deal with corrosive liquids without injury to the pump and without contamination or discoloration of the liquid itself.

Low Porosity Corundum

The type of stoneware used for the impeller is a special grade of corundum ware which has an exceptionally low degree of porosity, a smooth even finish and a high tensile strength, together with outstanding hardness and abrasion-resisting properties. For special purposes the volute and suction linings may also be made in the material.

The range of applications covers all acids (except hydrofluoric) and most alkalis, as well as food and chemical preparations for human consumption.

Construction Details

The Pulsometer-Doulton acid pump has an external body and cover of cast iron fully lined with Doulton acid-proof stoneware cemented in. The suction branch of the 1¼ in. size is 1¼ in. in diameter, arranged centrally in the cover, and the discharge branch is vertical, arranged to take standard stoneware connections 1¼ in., 1½ in. or 2 in. diameter. One aperture is provided, closed with a stoneware cover, enabling the interior of the pump to be drained.

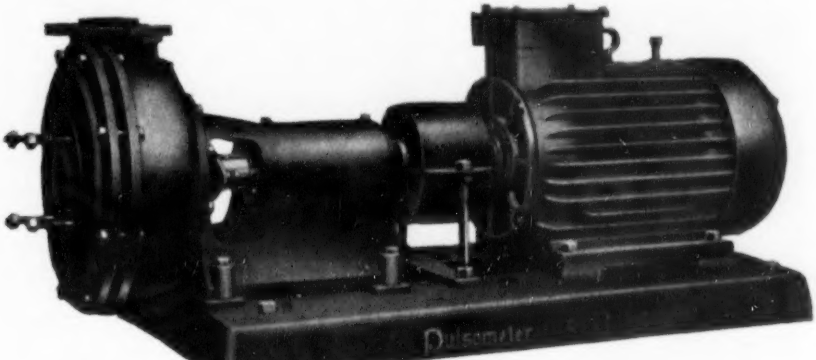
The Impeller

The impeller is of the single inlet shrouded type and is made in corundum stoneware; it is accurately ground and balanced to run without vibration, and is permanently secured to the spindle. The boss of the impeller is extended right through the stuffing box to protect the spindle, and specially designed vanes are provided on the impeller to reduce the pressure on the packing to a minimum. The stuffing box is of ample depth, provided with a split vulcanite or stoneware lantern ring with external connections, through which water can be led to dilute any leakage from the pump and carry away to the drain.

Gland Details

The gland, which is split to give ample room to handle the packing, is of vulcanite or stoneware reinforced by a metal flange. As the packing runs on a stoneware hub, the gland should be only finger tight, and knurled nuts are therefore provided. The spindle is of mild steel supported in a two-bearing hood, comprising a double thrust and journal bearing next to the pump, and a roller bearing at the driving end. The two bearings are moulded in a hood of very rigid construction with large openings at the side.

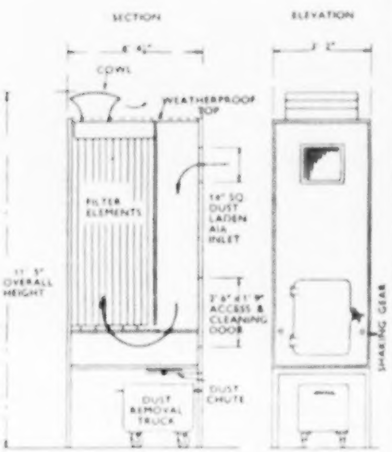
Further information can be obtained from the Pulsometer Engineering Company Limited, Nine Elms Iron Works, Reading.



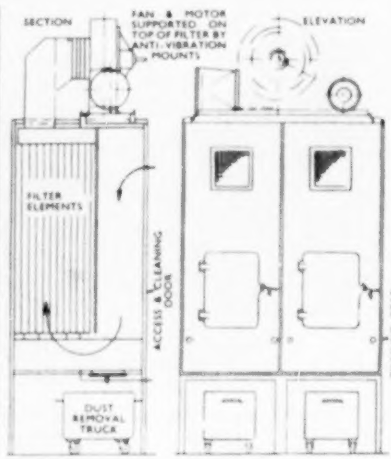
The Pulsometer-Doulton pump, all interior parts being made in acid-proof stoneware

"AIRFLO" DUST COLLECTION

THE INDUSTRIAL FAN AND HEATER CO. LTD., of Anne Road, Handsworth, Birmingham 21, have issued a leaflet under the above title. One of the main advantages claimed for the equipment is that the dust collecting units are made on the basis of standard units. It is also claimed that the units will deal efficiently with all classes and concentrations of dry fibrous dust and the collectors operate under either pressure or suction. The two illustrations show the layout operating at suction and pressure respectively. Type E are recommended for dry, non-fibrous, non-explosive dusts with an air temperature not exceeding 160° F. Type F covers fibrous dusts, Type G for moist and explosive dusts and Type J is a self-contained unit for one double ended polishing or mopping spindle. "Airflo" cyclones are used for handling wood, refuse, etc.



Arrangement of single unit under pressure with weather-proof top cover and standard dust removal truck



Arrangement of two units under suction with self-contained fan and motor and standard dust removal truck

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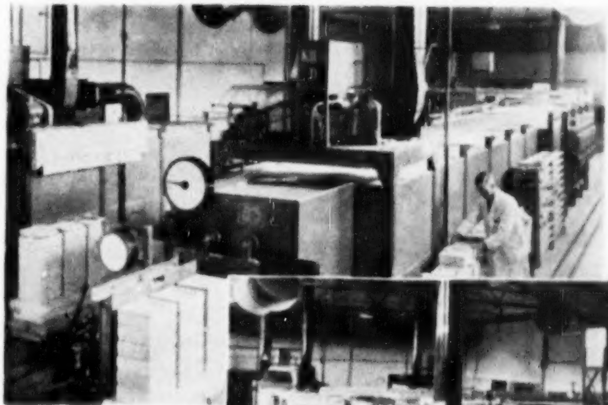

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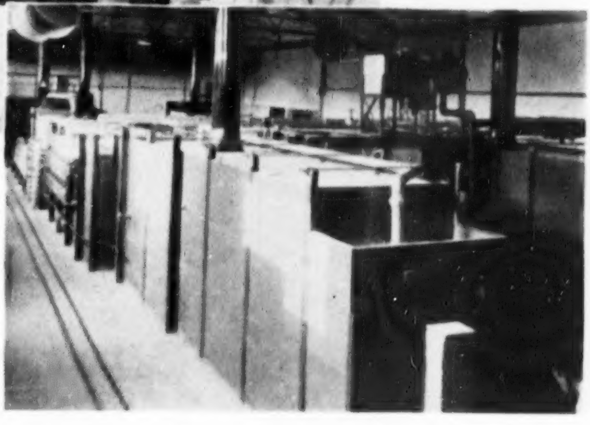

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